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ABSTRACT

Thirteen congenitally blind students (6-18 years old) who participated in a 2-year Piagetian-oriented remedial program experienced significant gains on 22 of 26 reasoning variables (as measured by a Piagetian battery), compared to a non-treatment group of Ss which achieved significant gains on seven of 26 variables. Results suggested the need for programs to train teachers of the visually handicapped in the application of Piagetian-based strategies. (Included are information on adaptation of reasoning tasks for the blind Ss and detailed analyses of results in conservation, classification, mental imagery/spatial relations, and formal-abstract relation.) (CL)

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Final Report

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COGNITIVE REMEDIATION OF BLIND STUDENTS

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ABSTRACT

The present project demonstrated the effectiveness of Piagetian-based training in the promotion of reasoning in congenitally blind children; provided an educational system for the remediation of reasoning; and developed, adapted and evaluated instructional modules for blind pupils. The sample of 39 subjects, CA 6-18, IQ 90-110 as measured by the appropriate Wechsler Verbal Scale was subdivided into three groups:

1) 13 congenitally blind subjects (treatment group);

2) 13 congenitally blind subjects (nontreatment group);

3) 13 sighted subjects (nontreatment group).

Comparison of the two congenitally blind groups on pre- and posttest scores on a Piagetian battery of reasoning assessments indicated that after a 17-month period the treatment group experienced significant gains on 22 of 26 reasoning variables; the nontreatment blind group achieved significant gains on 7 of 26 variables. Comparison of the blind treatment group with the sighted nontreatment group indicated that after training the blind treatment group continued to be deficient on only 3 of the 15 reasoning deficits identified on the pretest. Superior performance of the training group serves to suggest the need for programs to train teachers of the visually handicapped in the application of Piagetian-based strategies. Project products include teacher-training and student-activity manuals.

PREFACE

The present study was designed to develop and implement an intervention program that would enhance the development of reasoning in congenitally blind children. Previously, delays in the development of reasoning in blind children had been identified by Yvette Hatwell and confirmed by a study entitled *The Reasoning, Moral Judgment, and Moral Conduct of the Congenitally Blind* (Stephens and Simpkins, 1974). The latter study served as the first phase for the present study. While the initial study served to substantiate the work of Hatwell, the present study serves to extend her work by demonstrating that these deficits are remediable. The success of Phase II was directly related to the research and interpretive efforts of the Phase I staff. Efforts to develop an intervention program would have been futile without the continued support of those individuals and agencies that permitted access to their facilities and students. These included residential schools for the visually handicapped in Pennsylvania, New York, Virginia, Maryland, West Virginia, and North Carolina.

Gratitude is expressed to the staff and counselors at Overbrook School for the Blind, the New Jersey public schools, and the Logan School in Philadelphia. In this regard David Olson, Joseph Kerr and Muriel Korn were expecially helpful. In New Jersey the itinerant portion of the intervention program was sustained through the support of Nan Dempsey of the New Jersey Commission for the Blind and Visually Impaired.

The project is especially grateful to the parents who permitted sessions to take place in their homes, and to the students who gave up many hours of their free time to participate in the study.

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CHAPTER I - INTRODUCTION

Background Information

The presently reported research project evolved from a study conducted by Stephens and Simpkins (1974) which probed the specific effects that blindness -- as sensory deprivation -- has upon the development of reasoning, moral judgment, and moral conduct in blind persons ages 6 to 18. Findings from the previous study served to indicate that the congenitally blind subjects exhibited severe deficits in reasoning; deficits of 4 to 8 years were noted when the blind subjects were compared with sighted peers.

Based on the needs identified in the Stephens and Simpkins research a second phase was proposed and subsequently implemented. Thus Phase II, the presently reported project, has sought to determine whether blind subjects who are supplied individually appropriate opportunities to reason in ongoing Piagetian-based training situations will demonstrate gains in cognitive development which are significantly greater than those exhibited by blind students of comparable age and IQ who are not provided these opportunities.

The needs of the congenitally blind population identified by Stephens and Simpkins, and which are substantiated by Hatwell's (1966) previous research, tend to imply that although the blind can verbalize static or stored information, they are significantly impaired in their ability to reason logically in ongoing situations. Also, their findings serve to support Piaget's thesis (1960) that cognitive development proceeds as an individual interacts with his environment and that any curtailment of this interaction, e.g., that imposed by blindness, serves to inhibit the formation of the thought structures which are basic to logical reasoning.

Because his cognitive theory serves to explicate the progressive development of highly interrelated thought structures, Piaget questions the sagacity of attempts to accelerate development through drill in one specific area; rather he emphasizes the need to provide the child with opportunities for experiences commensurate with his level of cognitive functioning, and then, to let the child do the experiencing. The suggestion is particularly applicable to blind children of average intelligence since they generally have the potential, but not the environmental and interactional experiences required for the normal development of logical reasoning.

STATEMENT OF PROBLEM

Previous research by Stephens and Simpkins (1974) provided evidence that when compared with sighted peers of equivalent age and IQ, blind students (CA 6-18, IQ 90-110) evidenced average delays of 4 to 8 years in reasoning as measured by Piagetian assessments.

Provided with the data from the Stephens and Simpkins research (1974) the present study sought to determine if blind children who are supplied individually appropriate opportunities to reason in ongoing Piagetian-based training situations will demonstrate gains in cognitive development which are significantly greater than those exhibited by blind students of comparable age and IQ who are not provided these opportunities. Also, there was desire to determine if the type and quality of interaction with objects and people that support and lead to cognitive growth can be promoted in the blind student. Thus, the problem was threefold:

1. To demonstrate that reasoning and interaction deficits can be remediated,
2. to provide an educational system for the remediation of reasoning and for the increase of social and/or environmental interaction; a system which includes teacher training and evaluation of pupil training, and
3. to develop, adapt and evaluate instructional modules which are based on eight factorially defined areas of Piagetian reasoning.

Review of Relevant Literature

Jean Piaget's work in the area of child development has extended over a 50-year period. While his early writings were widely read in Europe and to some extent on this continent, it was during the decade of the 1960s that Piaget was "rediscovered" in America. Since his work has been translated and made available to English speaking researchers, investigations have been conducted to replicate/validate his research and to employ his developmental approach with diverse populations. In his analysis of cognitive development he posits that the individual passes through a series of stages in an invariant sequence. However, the age at which a given stage is achieved varies from individual to individual. The four stages of cognitive development posited by Piaget are:

1. Sensory-motor (approximately birth to 2 years). The period is characterized by development from a state of reflex activity to organized sensory-motor....(interaction) which permits increasing mastery of objects in the environment. (This initial stage is comprised of six sub-stages.)

(a)	Reflexive (0-1 month)	Simple reflex activity; example: kicking
(b)	Primary Circular Reaction (1-4.5 months)	Reflexive behavior elaborated and coordinated: example: a thing grasped becomes something to suck
(c)	Secondary Circular Reaction (4.5-9 months)	Repeats chance actions to reproduce an interesting change or effect; example: kicks crib, rattle shakes, so kicks crib again
(d)	Coordination of Secondary Schema (9-12 months)	Acts become clearly intentional; example: reaches behind cushion for ball
(e)	Tertiary Circular Reactions (12-18 months)	Discovers new ways to obtain desired goal; example: pulls pillow nearer in order to get music box resting on it
(f)	Invention of New Means through Mental Combinations (18-24 months)	Invents new ways and means; example: uses stick to reach desired object.

> 2. Preoperational (approximately 2 to 7 years). The child does not use logical operations in his thinking. Instead, he is perceptually oriented, makes judgments in terms of how things appear, and generally can deal with only one variable at a time....
>
> | | |
> |---|---|
> | (a) Preconceptual (2-4 years) | Capable of deferred imitation and of verbal expression, but speech is repetitious; frequent egocentric monologues. |
> | (b) Intuitive (4-7 years) | Speech becomes socialized; reasoning is egocentric; example: "to the right" means to his right. |
>
> 3. Concrete operations (approximately 7 to 11 years). Mobile and systematic thought organizes and classifies information. Thought is no longer centered on a particular state of an object. Instead it can follow successive changes through various types of detours and reversals, but because the operations are tied to action, they are concrete rather than abstract.
>
> 4. Formal operations (generally achieved after age 11). The stage is characterized by the ability to think abstractly, formulate hypotheses, engage in hopothetico-deductive reasoning, and check solutions. Thought now directs observations. (Stephens & Simpkins,1974, p. 5-6).

Inhelder (1953) cited the following criteria to define each stage:

1. Each stage contains a period of formation and a period of attainment.

2. The starting point for a higher stage is marked by the attainment of an earlier stage.

3. The order of the stages is constant although the age of attainment can vary.

> 4. The attainment of higher stages necessitates that preceding structures can be integrated or become a part of the later structures. (Stephens & Simpkins, 1974, p. 6)

A comprehensive review of Piagetian-based research is beyond the scope of the present report. Instead, consideration is given to studies which address the three basic areas that are involved in the present study: 1) application of Piagetian theory to research with the handicapped, 2) effects of blindness upon cognitive development, and 3) implementation of Piagetian theory in curriculum.

Application of Piagetian Theory in Research with the Handicapped

The application of Piagetian theory to programs for the handicapped has served to indicate that handicapped children differ in cognitive development from most non-handicapped children. Inhelder's (1968) research with mentally retarded children indicated that although both retarded and normal subjects progressed through the stages of cognitive development in the same sequence, the retarded did not achieve formal, or abstract, thought. Similar findings have been reported by Lovell and Slater (1960), and Mannix (1960). A study conducted by Stephens (1972) which compared the development of reasoning in retarded and in normal subjects (CA 6-21) further supported Inhelder's research. Stephens concluded that differences existed in the operational thought of normal and retarded persons, and also that as reasoning development proceeded in the retarded subjects the tempo was decelerated. Hence, she stressed the need to continue educational programs beyond the adolescent years in order to accommodate the slower learning rate of the retarded persons.

Piagetian-based research involving emotionally disturbed children also has served to indicate delays in the acquisition of higher level reasoning abilities. Studies by Howell (1971) and Pimm (1972) have indicated that the emotionally disturbed child is less capable of dealing with conservation tasks. Pimm posited that difficulties with the tasks could be related to the lack of appropriate social interaction.

Stephens and Sower (1976) conducted a study with low IQ (50-85 range) multi-handicapped children who were classified as emotionally disturbed. Data from the study served to confirm that the development of reasoning can be accelerated in the areas of classification and conservation if the subjects are provided individually appropriate activities. Little improvement was noted in areas of mental imagery and formal operations. There was note, however, that attainment of formal or abstract thought generally is not expected of persons in these subjects' age range (CA 6-14).

Research efforts by Furth (1966) and Boyd and George (1973) have examined cognitive functioning of deaf children. Furth's research served to indicate that verbal language is not essential for initial thought, rather language usage is dependent on the structure of intelligence. Boyd and George concluded that failure of deaf children in normal abstraction skills is only indirectly related to language deficiency and directly related to restrictive experiential stimulation in early life. They stressed the need to promote cognitive socialization through specifically structured experiential programs.

Effects of Blindness Upon Cognitive Development

Blind children comprise a small subgroup of the total population of school age children. While attention has been focused on the evaluation of blind persons (Clark and Jastrzembska, 1970) there is lack of consensus on the appropriateness of various approaches which currently are used in the assessment of cognitive development in blind children. The lack of consensus results in part from the inadaquacy of measures currently employed to evaluate the development of sighted children (DeVries, 1974). The central issue concerns the use of IQ as a measure of intelligence. Both DeVries and Kohlberg (1975) urged the consideration of Piagetian assessments as an alternative to present psychometric methods. Newland (1970) stressed the need for an assessment for the blind that focuses on the "process," i.e., the method a student uses to solve a problem. Rusalem (1970) indicated a need for assessments that are practical for the teacher and measure the student's potential for development. Provided with information of this type individually appropriate experiences could be designed.

An approach which was based on developmental assessment was available through the work of the Geneva School. The techniques have been used with sighted children and children with various exceptionalities. The first major work using an adaptation of Piagetian tasks with the visually handicapped was accomplished by Hatwell (1966) in France. Her results served to suggest that blind children experience deficits or delays of two years or more in the acquisition of conservation and classification skills. However, past studies have not been consistent in the documentation of cognitive lags. Studies conducted by Gottesman (1975) and Cromer (1973) which assessed conservation abilities served to indicate that major delays are not characteristic in the development of the blind. Tobin (1972) found that the age range for attainment of conservation as measured by conservation of substance tasks was extended for the visually handicapped; substantial numbers of his subjects did not conserve until after the age of 9 or 10. Research by Miller (1969) served to indicate that the performance of partially sighted subjects was superior to that of the congenitally blind subjects on conservation tasks; there was suggestion that the congenitally blind might never master conservation concepts. Brekke, Williams, and Tait (1974) concluded that the degree of blindness was less important than the place of residence; in their studies institutionalized blind children achieved conservation skills later than blind subjects who resided in other settings. A study of classification tasks by Higgins (1973) indicated that the blind did not display developmental delays that could be attributed to delays in the formation of intellectual structures. Data obtained from classification and seriation tasks administered by Friedman and Pasnak (1973) served to indicate that the sighted generally did better than the blind; additionally there was indication that as blind children advance in age they have progressively greater cognitive deficits and their performance might tend to be equal to or lower than that of younger sighted children. They also concluded that if cognitive development can be accelerated through Piagetian-based training, the blind child would be one who would be most amenable to the training.

In an effort to accelerate conservation acquisition in blind children, Lopata and Pasnak (1976) implemented a learning set training procedure which incorporated both substance conservation and related subordinate concepts. The data served to indicate that the training group's conservation of substance scores, weight conservation scores, and IQ were significantly increased.

A study of reasoning ability in congenitally blind children conducted by Stephens and Simpkins (1974) found cognitive delays of 4 to 8 years. The study examined mental imagery and formal operations as well as conservation and classification abilities. Initially the results seem to be in conflict with earlier studies;

however, a review of the CA range employed in their study indicates that their sample represented a wider age range than did samples from previous research. Previous research efforts were concerned primarily with students within the 6-10 age range, whereas Stephens and Simpkins' sample was composed of three subgroups, CA 6-10, 10-14, and 14-18. The differences in performance of the sighted and blind were greatest in the subgroups CA 10-14, and CA 14-18. Equivalent performance of the CA 14-18 blind subjects with CA 6-10 sighted subjects occurred on 19 of the 26 reasoning variables. These findings serve to substantiate Friedman's and Pasnak's hypothesis, i.e., that when older blind children are compared with sighted children of equivalent age, their cognitive lags would be greater than the cognitive lags that would be evidenced when younger blind children are compared with equivalent-aged sighted. An increase in deficit with age would be expected since late childhood and early adolescence are periods of rapid concept acquisition in sighted persons.

Because of their sensory deficit, congenitally blind children are at a disadvantage from birth onward. The young child is restricted from interacting with his environment and may be prevented from acquiring appropriate information about events and objects surrounding him. This lack of actual intervention can threaten ego development by encouraging passivity and subjectivity (Adelson and Fraiberg, 1974). The auditory ability of the young blind child is viewed by Adelson and Fraiberg (1974) as insufficient to completely eliminate the delays which accompany blindness. Likewise efforts to intervene at an early age are unlikely to completely eliminate the delay. While use of other sensory modalities cannot compensate completely for the loss of vision, Scholl, (1973) stated that other sources of sensory input must be exploited. Research by Millar (1974) provides evidence that the blind child's tactual shape recognition was less accurate but faster than the sighted. In a previous exploration of tactile ability Nolan and Morris (1969) reported that the ability to tactually discriminate is affected by the intensity of tactual stimulation and also by the variation of quality of intensity. Doherty (1974) assessed visually handicapped and sighted children on a conservation of substance task under visual and haptic conditions. He concluded "that it is the blind child's inability to interact with the environment that results in a lag in the formation of intellectual structures" (Doherty, 1974, p. 4), rather than the haptic modality per se.

Hatwell (1966) has concluded that early impoverishment of perceptual experiences due to visual deprivation is followed by an important delay in the constitution of spatial operations. This delay serves to suggest that during the initial stages of the construction of the notion of space, a close tie exists between perceptual (or Piagetian 'figurative') aspects and imagery, on the one hand, and logical and rational aspects (operative), on the other hand, i.e., any damage to the inferior level has repercussions at the superior level.

Millar's (1975) research on spatial memory provides evidence that repeated experience involving touch and memory cues with spatial layouts is important for the blind student. With adequate experience the blind can perform as well as their sighted peers on spatial tasks which occur within the body space. However, they may be deficient in tasks which involve events at a distance from the body (Jones, 1975). Research in the areas of mental imagery and spatial relationships has led Swallow (1976) to suggest that..."the reproductive image level is where we may again assume that there are catastrophic effects upon the cognitive development of the blind child due to experiential deprivation. This may be more detrimental than the loss of ability to perceive the environment" (p. 269). Swallow (1973) also has stressed the need for preschool programs which assist in the development of the foundation for higher order spatial relationships, and the need (1976) to train teachers to provide a cognitively oriented environment.

Extensive work with the blind in areas of spatial relations and mental imagery has not been accomplished at this time. The limited research which has been carried out has served to indicate lags in the area of spatial relations and mental imagery in the blind (Stephens & Simpkins, 1974). Difficulties that the congenitally blind experience in this area have been documented by Barraga (1976):

> Spatial orientation and concept formation require a long and tedious learning process for the totally congenitally blind child. He will learn to use his other senses, but must be constantly encouraged and supported by adults, who carefully plan sequential experiences as he gradually acquires skills. The concepts he acquires will necessarily be different from those acquired through the use of vision (p. 33).

Implementation of Piagetian Theory in Curriculum

While large scale Piagetian-based curriculum intervention programs for handicapped pupils are not readily available, efforts to develop Piagetian-oriented materials for the developmentally normal child have been undertaken. Programs which stress a Piagetian approach generally utilize activities which foster social/environmental interaction and provide concrete manipulative experiences.

The use of Piagetian-based science programs has been advocated for early childhood education (Howe, 1975). The implementation of such science programs is considered to be an aid in the development of logical thinking and a means by which the child can organize the world around him. The flexibility inherent in a Piagetian approach also is seen as an asset at higher grade levels (Sayre and Ball, 1975). Used in biology classes (Craeger, 1975; Lawson, 1975) the approach leads the student to discovery which is congruent with his own developmental rate.

Regardless of grade level, an individual program should be congruent with the child's developmental level (Appel, 1977). Because of the acceptance of an inquiry type approach in the teaching of science, the implementation of Piagetian influenced programs has had its greatest impact on science curriculums. Included among the more widely accepted programs are SCIS (Science Curriculum Study, 1971), ESS (Elementary Science Study, 1969), Nuffield Junior Science (1967), and BSCS (Biological Science Curriculum Study, 1976).

Recent work by Thier (1971) and Thier and Hadary (1973) represents one of the initial efforts to provide Piagetian based intervention activities in training programs for blind students. Linn and Thier (1975) reported that visually impaired children made immediate gains in manipulative and concrete skills when exposed to the Adapted Science Materials for the Blind curriculum.

Piagetian approaches also have been applied to other curriculum areas. Copeland (1974) designed a program to aid teachers in discerning a child's stage of development as a basis for determining his appropriate math level. The development of mathematical skills through the application of Piagetian theory also has been undertaken with retarded students (Kiraly, 1974). Application of Piagetian theory in the areas of language arts and reading is evident in the work of Brekke and Williams (1975), De Mao (1976), and Dimitrovsky and Almy (1975). Preseisen (1977) posits a Piagetian approach in social studies is one which provides focus for the full development of the child's personality and his respect for human rights and fundamental freedoms. Both Preseisen (1977) and Hallam (1969) address the need to present concepts that are parallel to the child's present cognitive organization. Similar concerns over teacher expectations and over presentation of material compatible with the child's present cognitive level was expressed by Lansing (1970) in art education and by Schmitt (1971), Hawn (1975), and Perney (1976) in music education.

Numerous studies have sought to devise teaching strategies which would assist a child in reaching successively higher stages of cognitive development. Kamii's (1973) and Weikert's (1971) pre-school programs demonstrate the benefits to be derived from a Piagetian pre-school curriculum. Lavetelli's (1970) early childhood curriculum includes a teacher's manual and pupil activities which adopt a Piagetian approach to school readiness training. Almy, Chittenden, and Miller (1966) also have supplied activities which are designed to promote logical thinking in elementary school children.

Not totally in keeping with Piagetian theory (because these attempts are designed to achieve isolated development in one specific area rather than addressing consideration to the development of a network of highly interrelated mental structures) are the multitudinous reported efforts to provide intervention activities to promote the acquisition of a particular Piagetian reasoning skill, e.g., conservation. One of the earlier and more successful efforts of this type was Brison's and Bereiter's (1967) demonstration that the acquisition of conservation in both normal and retarded children could be promoted by specific isolated training in this area. Success in the conservation training of children from varying populations has been reported by numerous researchers and includes studies by Lefrancois (1968), Whiteman and Persack (1970), Roll (1970), Peters (1970), Siegler and Liebert (1972), and Murrary (1972). The conclusion made by Brainerd and Allen (1971) after their review of conservation studies was that basic or first order conservation skills, e.g., number, length, and substance, are teachable if training opportunities are supplied during a period when they are developmentally appropriate.

In answer to the need to train teachers, not only in Piagetian theory but also in its pedological application, Lavatelli prepared her Teacher's Guide, Early Childhood Curriculum (1970); Pulaski (1970) presented explanations and suggestions for teachers; Furth compiled Piaget for Teachers (1970); Furth and Wachs (1974) authored Thinking Goes to School; Athey and Rubadeau produced Educational Implications of Piaget's Theory (1970); Almy, Chittenden, and Miller introduced teachers to Young Children's Thinking (1966); Brearley and Hitchfield devised A Teacher's Guide to Reading Piaget (1966); Kohlberg and Mayer considered Development as the Aim of Education (1972); Pepper (1973) discussed The Self Managed Child; Phillips compiled Piaget's Theory of Intellectual Development: Application to Teacher and Curriculum Development (1972); and Schwebel and Raph (1973) produced Piaget in the Classroom. In addition Lowery (1975) developed the Learning About . . Series; and Sund (1976) developed a multi-media program, Piaget for Educators.

In summary, the feasibility of implementation of Piagetian theory in (1) various curriculum areas, (2) remediation of a particular reasoning skill, e.g., conservation, (3) promotion of successive levels of cognitive development, (4) definition of cognitive deficits which characterize various types of handicaps, and (5) teacher training, has been demonstrated. There is note, however, that to date there is no reported system of teacher training which promotes knowledge of Piagetian theory, skill in the assessment of reasoning and the interaction patterns that support reasoning development, and proficiency in the implementation, evaluation and validation of a Piagetian-based system of instruction.

CHAPTER II - METHODS

Project Program

The Piagetian-oriented remedial system which was employed in the presently reported project included: 1) teacher and pupil training and its evaluation, and 2) design, use, and evaluation of remediation modules for pupils. Within the framework of a systems approach, three subsystems were developed to coordinate project activities: 1) master teacher training, 2) student remediation, and 3) system planning and operating. The subsystems provided interaction of one component with another; and the subsequent feedback, evaluation and modification were related and ongoing. An overview of the systems approach employed in the project (Remediation Systems Manual) is included in the Appendix (p. 79).

Master Teacher Training Subsystem

Following establishment of training procedures, two teachers with backgrounds in Piagetian theory and special education were selected for training. During a five-week preservice workshop and during regular monthly inservice sessions, teachers were trained to 1) administer Piagetian assessments, 2) develop activities, and 3) implement process-oriented teaching strategies. The planning, data collection and review procedures provided feedback which augmented development of an individually prescribed competency-based training program for each master teacher. Data gathered from periodic administration of the following instruments served to provide the basis for individual teacher profiles.

1) *Runner Studies of Attitude Patterns* (Runner, 1973);

2) *The Flanders System of Interaction Analysis* (Flanders, 1966);

3) *Individual Cognitive Demand Schedule* (Lynch and Ames, undated)

4) *Process Oriented Teacher Checklist* (Stephens, 1975).

In addition, data generated by the student remediation subsystem, e.g., administration of Piagetian assessments and observation of teacher performance, provided feedback for development and evaluation of the teacher training model. The Training Manual for Teachers of the Visually Handicapped: A Piagetian Perspective which includes training procedures developed and validated during the remediation program is outlined in the Appendix (p. 87).

Student Remediation System

An approach to remediate reasoning was devised which included the design and the evaluation of instructional activities and remediation modules. This approach focused on an interactionist method of remediation in order to facilitate development of the pupil's general cognitive framework. Efforts centered on engineering the child's environment in a manner that optimized the coordinated exercise of his existing cognitive structures within his present level of interaction competency. Emphasis was on: 1) the process rather than the content or product of knowledge, 2) the child's spontaneous adaptive behavior, and 3) the interaction between child, teacher, and physical environment.

The process oriented Piagetian remediation model for evaluation and facilitation of cognitive growth provided flexibility for individualization of instruction. Based on data obtained from the pretreatment administration of the Piagetian battery of reasoning assessments (October, 1974), individual student profiles were developed. The needs identified in the profile served as a basis for the development of remediation modules. The modules permitted the subject to choose from a variety of training activities (appropriate for his interest level) which were designed to provide opportunity for material and social interaction, and to promote conceptual development in the particular area of reasoning for which individual remediation was desired. The subject's level of reasoning and interaction were determined at both the initiation and the completion of the module. If after initial use, review of the module revealed continuing weakness in that specific remedial area, the module was expanded to provide additional training activities.

Data obtained from administration of the Piagetian battery of reasoning assessments at the end of the first year of training (May, 1975) served as the basis for the revision of student profiles. Activity development during the second year of remediation addressed the needs identified by the revised profiles. Data gathered from the posttreatment administration (May, 1976) of the reasoning assessments served to validate the remedial system and served to determine which modules promoted significant growth. A description of the Student Activity Guide: A Piagetian Perspective which includes modules implemented during the remediation program is presented in the Appendix (p. 89).

System Planning and Operating Subsystem

This subsystem provided the direction necessary for coordination and development of a remediation system which contained the necessary review procedures to ensure that the teacher training program and the student remediation program satisfactorily accomplished the project objectives. Data gathered from operation of the teacher training and student remediation subsystems were evaluated; following this, necessary systems modifications were instituted when indicated. The process was accomplished through internal bimonthly operation reports and weekly staff sessions.

As a result of the system review process a decision was made to incorporate all materials related to the teacher training subsystem into one manual. There were two teacher oriented manuals scheduled for publication, i.e., a process-oriented teacher evaluation and training manual for training teachers of the blind, and a process oriented teacher's guide for evaluation and remediation of blind students with suggested materials and remediation modules. Since both manuals shared a common body of related material, the combination of the two manuals avoided duplication of material and reduced future publication costs. The expense of producing two training manuals for a low incidence handicap such as blindness, would have significantly raised the purchase price of the program, which in turn would have jeopordized its extended use. Hence the combination of the two manuals was both practical from a teacher's perspective and cost effective. Similarly, the limited appeal of the Remediation Systems Manual resulted in its inclusion in the Appendix of this report.

Project dissemination activities, including preparation of the Student Activity Guide: A Piagetian Perspective and the Training Manual for Teachers of the Visually Handicapped: A Piagetian Perspective were directed under this subsystem. Dissemination activities are listed in the Appendix (p. 77).

Population and Sample

A treatment sample of 18 congenitally blind subjects who attended schools within a 50-mile radius of Philadelphia was selected from the 75 congenitally blind subjects assessed in the Phase I study. From the remainder of the Phase I sample, a nontreatment (control) group was randomly selected and matched by sex and age with the treatment group.

The nontreatment blind sample included students from New York, New Jersey, Maryland, Pennsylvania, West Virginia, North Carolina, Delaware, and Virginia. Prior to the onset of intervention two subjects assigned to the treatment group elected not to participate in the project. Since all available subjects within the greater Philadelphia area had been included in the treatment sample, the number of subjects in the nontreatment sample was reduced to 16.

Attrition during the two year remediation period further reduced the treatment group to 13. As a result of the time required by the pupils for academic programs and the need for ancillary services, parents of three subjects expressed a desire to discontinue remediation sessions. To maintain equivalence, the number of nontreatment subjects also was reduced to 13. The three subjects who were dropped from the nontreatment sample were equivalent in age and IQ to the three treatment subjects who withdrew. There were eight residential and five public day school students in each blind group. The criteria employed for sample selection in the original study were continued in the present one: these criteria included:

1) congenitally blind subjects, i.e., light perception or less and blinded before the age of 4 years,

2) CA 6-18,

3) IQ 90-110 as measured by the appropriate Wechsler verbal scale, and

4) no other handicapping condition.

In addition to the nontreatment (control) blind group, a comparison sample of sighted subjects (N=13) was randomly drawn from the data pool utilized in the Phase I study and matched with the treatment group by sex and age. Sighted subjects were those used previously by Stephens (1972); their assessment scores already had been obtained. The 13 subjects attended public school classes in the Bucks, Montgomery, and Philadelphia county school systems in Pennsylvania. The three groups, blind treatment, blind nontreatment and sighted nontreatment were drawn from cross-sectional samples of three age ranges, 5-10, 10-14, and 14-18.

The sample that participated in the study throughout the two-year remediation period was composed of the following subsamples:

5 treatment
5 nontreatment (blind)
5 nontreatment (sighted)
(3 male, 2 female) ages 6-10,

4 treatment
4 nontreatment (blind)
4 comparison nontreatment (sighted)
(2 male, 2 female) ages 10-14, and

4 treatment
4 nontreatment (blind)
4 nontreatment (sighted)
(2 male, 2 female) ages 14-18.

There is acknowledgment that the sample criteria were based upon guidelines established in the Phase I study; the age for onset of blindness (as recorded in school records) was prior to 4 years of age. All of the members of the treatment group were listed as blind from birth with only two exceptions; these two were blinded before 2 years of age. In the nontreatment blind group nine subjects were blind at birth, the remaining four were blinded at age 3 or younger.

Description of Setting

Assessment

The three waves of the Piagetian assessments (pre-, and posttreatment) and the Wechsler verbal scales were administered in classrooms provided by the subjects' schools. If a suitable testing area was not available or if scheduled testing did not coincide with school sessions, the subject's home or a nearby facility was utilized.

Intervention

Three 45-minute intervention sessions per week or their equivalent were scheduled during the subjects' academic school year. Sessions with the eight residential students were conducted in a room provided by the school. When possible, intervention sessions with the five public day school students were scheduled within their classroom buildings. However, for three subjects time constraints, e.g., mobility and braille instruction in addition to regular academic courses, required that one session per week be conducted at the subjects' homes.

Despite subject illnesses and alterations of school schedules due to inclement weather and special programs, subjects received an average of 97 hours of individualized remediation during the 17 month intervention period.

The three subgroups did not differ significantly in age, IQ, and social status.

	Treatment	Nontreatment (Blind)	Nontreatment (Sighted)
$\bar{X}$ CA	12.7	12.6	13.6
$\bar{X}$ IQ	100.8	100.1	98.0

Social status as measured by Warner's Index of Social Status (McGuire and White, 1955) was determined to be upper-lower class for both blind samples and lower-middle class for the sighted nontreatment group.

Descriptions of Variables Being Studied

The Piagetian assessment battery was composed of 19 reasoning measures. Four of the reasoning assessments had two or more subtests; therefore the number of reasoning variables was 26. Successful adaptation and implementation of Piagetian reasoning assessments with the visually handicapped was accomplished previously by Hatwell (1966). The Piagetian reasoning assessments utilized in the present study were adapted for blind persons by Simpkins and Stephens (1970). The adaptations were tested at Overbrook School for the Blind and Temple University. Prior adaptation of the conservation assessments was accomplished by Miller (1969) at Temple University and Overbrook School for the Blind. Test-retested reliability for the conservation assessments (five week interval) ranged from .74 to .84.

The reasoning assessments provided measures of: (a) conservation, (b) logic-classification, (c) mental imagery and spatial relations, and (d) abstract/formal operations.

Prior to the administration of the reasoning assessments, a preliminary experiment was presented to determine the subject's ability to use the terms "same", "more", and "less" appropriately (Griffiths, et al., 1967).

During administration of the Piagetian reasoning assessment battery, a clinical assessment technique was utilized which sought to determine the thought processes used by the subject to obtain answers to problems involving ongoing situations.

A brief description of the original task and of the adaptation for the blind are presented in Table 1.

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Insert Table 1 about here

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Scoring Procedures

Two types of scores are assigned to the reasoning assessments: dichotomous (pass-fail) and point scale scores. The one-to-nine point scale is composed of the following intervals:

1. Fail
2. Oscillation - Incorrect: Initial correct response is altered to an incorrect one
3. Oscillation - Correct: Initial incorrect response is replaced with a correct one
4. Pure intuitive: The correct answer is given but reason for the statement is lacking
5. Concrete intuitive: The correct answer reflects perceptual influence

Table 1

Descriptions of the Reasoning Tasks

Subtest	Original	Adaptation for the Blind
	Conservation	
One for One Exchange	In this task, the experimenter had a "store" (a basket containing 12 packages). The child was given eight dimes and instructed to exchange a dime for each package he bought until all the money was spent. At the conclusion of his purchases, the child was asked whether he had the same number of packages as the experimenter had dimes. Later the roles (shopper, grocer) were reversed.	None
Term to Term Correspondence	After nine egg cups were arranged in a straight line (with 1-inch intervals between each) the subject was requested to place an egg in front of each egg cup. After he agreed that there were the same number of eggs as egg cups, the egg cups remained in place but the eggs were moved much closer together. Immediately following each transformation, the child was asked whether there were as many eggs as egg cups.	To promote ease in tactile examination, checkers were substituted for the egg cups and poker chips for the eggs. The examiner manipulated the child's hands as he made the transformations.
Conservation of Liquids	Two identical beakers were filled with equal amounts of water (one clear water, the other colored water). After the child agreed there	Clear water was used in both beakers. The child did all pouring, but when necessary

Table 1 - Continued

Subtest	Original	Adaptation for the Blind
	Conservation	
	was the same amount of water in each beaker, the content of one beaker was poured successively into a tall cylinder, a short flat beaker, and four small beakers of equal size. After each transfer, the child was asked whether the containers had the same amount of water.	was assisted by the examiner.
Conservation of Length	The child chose two rods of equal length (8 inches) from a group of 6 -, 8-, and 10-inch rods. After he confirmed the equality of the two 8 inch rods, the rods were placed parallel to each other. The experimenter then moved one rod 4 inches to the right, then 4 inches to the left, and finally both rods were moved simultaneously; one 4 inches to the right, the other 4 inches to the left. After each shift, the child was asked if the rods were the same length.	When the rods were placed parallel to each other the child was asked to place both hands on top of the rods in order to observe the movement tactually. Rods were slightly flattened on one side to prevent rolling.
Conservation of Length (Rod Sections)	The procedure was similar to the above except four rods, each 4 inches long, were compared to one 16-inch rod. The transformations consisted of placing the four small rods in a "W" shape, and "M" shape, and a "--V" shape.	Rods were slightly flattened on one side to prevent rolling. The child placed both hands on top of the rods as they were manipulated.

Table 1 - Continued

Subtest	Original	Adaptation for the Blind
	Conservation	
Conservation of Substance	After the child agreed that two 6-inch balls had the same amount of clay, one ball was successively transformed into a "hot dog," a "pancake," and into a dozen small pieces. In each case, the child compared the amount of clay in the transformed ball with that in the unchanged ball.	Transformations from ball to "hot dog," from ball to "pancake," and from ball to twelve small pieces were made by the subject.
Dissolution of Sugar Sugar (1 Wt.) Sugar (2 Subst.)	Two identical beakers containing equal amounts of water were displayed. Later a cube of sugar was placed in one beaker and the child was asked (1) if the two beakers still weighed the same, (2) if, when dissolved, there was as much sugar in the water as there had been in the cube.	The child weighed the two beakers of water and two sugar cubes to establish equality of weight. He also established equality of water levels either by judging from the placement of rubber bands around the beakers to indicated water levels or by feeling the water in the glasses. The subject dropped one sugar cube in the water; the other sugar cube remained on the table.

Table 1 - Continued

Subtest	Original	Adaptation for the Blind
	Conservation	
Conservation of Weight	Two clay balls of equal weight were placed on a scale. After the child agreed to their equality, the transformations to "hot dog," "pancake," and a dozen pieces were made. In this instance however, the child judged the weight rather than the size of the transformed ball.	Transformation was made by the subject.
Conservation of Volume (1-3)	After the youngster agreed to the equality of two clay balls and the equality of two beakers of water, one clay ball was successively transformed into a "hot dog," "pancake," and a dozen small pieces and the child was asked whether the water levels in the beakers would remain the same if the transformed ball was placed in one and the nontransformed ball in the other.	All transformations were made by the subject.
	Classification	
Intersection of Classes	Two rows of pictures were presented. One, a horizontal row, contained five pictures of the same object with each picture of a different color; the other, a vertical row, contained five pictures of the same color but of different objects.	Two rows of wooden forms were presented. On one row were four wooden cutouts of different shapes but the same texture. The other row

Table 1 - Continued

Subtest	Original	Adaptation for the Blind
	Classification	
	Instructions were to pick a single picture (from an assorted array) which would relate appropriately to both rows if it were placed at the intersection of the two rows.	contained four wooden cut-outs of the same shape but with different textures. Instructions were to pick a piece from an assorted array to place at the intersection of the two rows which would relate appropriately to both rows. Textures used were those found to be most highly discriminable by Nolan & Morris (1969).
Class Inclusion (Beads)	A box containing 10 wooden beads, eight red and two yellow, was displayed, and the subject was required to judge whether there were more wooden beads or red beads in the box. Additional questions were derived from modifications of the basic experimental arrangement.	The box contained 10 beads, eight of one shape and two of an obviously different shape. The child chose a name for each shape and his attention was drawn to the fact that all the beads were made of wood.

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Table 1 - Continued

Subtest	Original	Adaptation for the Blind
	Classification	
Classification (Animals) Class (3) Class (4) Class (5b)	Task requirements were to sort a set of 17 pictures into three related piles (ducks, birds, and animals). After the initial classification, the subject was questioned on class inclusion and possible class extensions.	Fresh foods were sorted into three related piles (apples, fruits, and foods). After the initial classification the child was questioned on class inclusion and class extension.
Changing Criterion	Forty cardboard geometric figures were to be sorted into two stacks; 20 figures were round, 20 square; 20 figures were red, 20 blue; 20 figures were large, 20 small. After the subject explained his classification, he was encouraged to sort on another criterion. The procedure was repeated for a total of three sorts. Finally, the subject was asked to recall his initial classification.	The 20 red figures were replaced by 20 sandpaper figures and the 20 blue figures by 20 smooth figures.
	Operativity and Symbolic Imagery	
Rotation of Beads	A stiff wire on which three different colored beads were mounted was exhibited. Following this the	Three differently shaped beads (strung consecutively

Table 1 - Continued

Subtest	Original	Adaptation for the Blind
	Operativity and Symbolic Imagery	
	beads were placed in a tube and the tube was rotated. The task was to judge which of the three beads would emerge first from the tube.	on a stiff wire) were tactually examined by the subject and given names. The subject assisted in placing the beads in the tube and placed his hands on the examiner's hands in order to follow the rotations.
Rotation of Squares	A board on which two cardboard squares (one red, one blue) were mounted was presented to the subject and he was required to draw the anticipated rotated positions of the red square. In a second procedure, the subject was asked to select the one drawing which represented the way the red square would appear at a specific position as it was rotated clockwise around the fixed point.	The squares of two colors (red and blue) were replaced by squares of two textures (smooth and rough) which were tactually inspected. Because no method was found to adapt the drawing of anticipated rotations, the part of the test which required drawing was eliminated.

Table 1 - Continued

Subtest	Original	Adaptation for the Blind
	Operativity and Symbolic Imagery	
Changing Perspectives (Mobile and Stationary)	A cardboard tower, house, and tree were placed in specified positions on a table. After moving to consecutive positions around a table, the subject was required to find a drawing which represented the complex when viewed from each of eight perspectives. In a second task, the subject remained seated, and was asked to indicate where a doll would have to stand in order to see the complex at a perspective which corresponded to the perspective depicted in a drawing shown to him.	Raised line drawings of the eight perspectives were used in the first and second parts. In the second part, the doll was eliminated and the child asked where he would have to stand in order to have the perspective correspond to the drawing shown to him.
	Abstract Operation	
Combination of Liquids (Chemistry)	Five identical bottles, each filled with a colorless liquid were placed on a table. Three bottles contained chemicals, the fourth bottle contained a neutralizer, and the fifth water. Combined liquids from three would produce a dark yellow color. The task was to determine which of the three liquids should be combined to obtain the dark yellow color.	Five identical bottles were placed on the table. The subject was told his task was to find which of the liquids, when combined, would produce a dark yellow color. When the subject used the correct combination of bottles he was informed that he had obtained the correct color.

Table 1 - Continued

Subtest	Original	Adaptation for the Blind
	Abstract Operation	
Dissolution of Sugar (Volume)	Two identical beakers containing equal amounts of water were displayed. Later a cube of sugar was placed in one beaker and the child was asked if the water levels in the two beakers remained the same.	The child weighed the two beakers of water and two sugar cubes to establish equality of weight. He also established equality of water levels either by judging from the placement of rubber bands around the beakers to indicate water levels or by feeling the water in the glasses. The subjects dropped one sugar cube in the water; the other sugar cube remained on the table.
Dissociation of Notions of Weight and Volume	After the child agreed that two identical plastic beakers contained the same amount of water, cylinders varying in weight and material, but of equivalent size, were placed in each beaker. Prior to each immersion, the child was asked to predict whether the water levels would remain the same after the cylinders were placed in the water. In a further task, the examiner placed a	At the opening of the experiment the subject was encouraged to tactually explore each of the cylinders.

Table 1 - Continued

Subtest	Original	Adaptation for the Blind
	Abstract Operation	
	large cylinder in one beaker and the subject was requested to select from a variety of smaller cylinders the cylinder or cylinders which, when placed in the second beaker, would cause the water in the second beaker to rise to the same height as the water in the first.	
Conservation of Volume (4)	After the youngster agreed to the equality of two beakers of water, two balls, one of clay and one of metal of equivalent volume were presented. The clay ball was successively transformed into a "hot dog," "pancake," and twelve small pieces and the child was asked whether the water levels in the beakers would remain the same if the transformed ball was placed in one and the metal ball in the other.	All transformations were made by the subject.
Classification (Animals-Class 5a)	The task is a subtest of the classification animals assessment and involves the ability to simultaneously group and subgroup. Pictures of four ducks and three other birds were placed on the table and the child was asked whether there were more ducks or birds.	The child was given four apples and three other fruits, and was asked if he had more apples or more fruits.

Table 1 - Continued

Subtest	Original	Adaptation for the Blind
	Abstract Operation	
Transfer from Two to Three Dimensions	An irregularly shaped cardboard frame was produced which had a thumbtack in the center. The subject was asked to place a tack in exactly the same spot on an identically shaped board. Spaghetti was provided to serve as a measuring device. Additional tasks involved oval and rectangular shaped boards. A final task required the subject to place a ball inside a wooden box-type frame in exactly the same spot occupied by a ball in an identical wooden box-type frame. Again, spaghetti was used as a measuring device.	None

6. Concrete with reversibility: The correct response addresses consideration to pertinent elements, but there is no indication of reversibility of thought processes

7. Concrete with reversibility: Responses indicate an ability to reverse thought processes

8. Concrete merging into formal: Answers suggest transition from concrete to abstract thought processes

9. Formal: Ability to solve problems without recourse to concrete materials is indicated (Stephens & Simpkins, 1974).

The point score of each subtest is indicated in Table 2. Point scale intervals for each assessment are detailed in the Piagetian assessment manual (Stephens & Simpkins, in press).

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Insert Table 2 about here

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Reliability of Reasoning Measures

Two-judge inter-rater reliability was established for reasoning assessments that were adapted for the blind. The reliability coefficients for point-scale scores ranged from .92 to 1.00 (Stephens and Simpkins, 1974). Reliability of the Wechsler scales for use with the blind has been determined by Tillman (1967a, 1967b), Tillman and Osborne (1969), and Bauman (1973). Further information regarding use of the Wechsler Scales with the blind is available in Scholl and Schnur (1976).

Collection of Data

During the preservice workshop, master teachers were trained in assessment administration. Under supervision of the project director, three waves of

Table 2

RANGE OF POINT SCALE SCORES FOR REASONING ASSESSMENTS

	Number Sub-scores	Max. Subscore Value	Score Range for Assessment	
			(min.)	(max.)
Conservation				
One for One	2	6	2	12
Term to Term	4	6/7[a]	4	27
Liquid	3	7	3	21
Length	3	7	3	21
Length (Rods)	3	7	3	21
Substance	3	7	3	21
Dissolve Sugar (Subst.)	2	6	2	12
Dissolve Sugar (Wt.)	2	6	2	12
Weight	3	7	3	21
Volume (1-3)	3	9	3	27
Classification				
Class Intersection	8	3	8	24
Class Inclusion (Beads)	4	1	0	4
Classes (3)	4	6	4	24
Classes (4)	6	6	6	36
Classes (5b)	1	6	1	6
Change Criteria	3	1	0	3
Imagery/Spatial Relations				
Rotate Beads	5	5	5	25
Rotate Squares	6	1	0	6
Perspective (Mobile)	8	6	8	48
Perspective (Stationary)	8	6	8	48
Abstract Operations				
Combine Liquid (Chemistry)	1	4	1	4
Dissolve Sugar (Vol.)	1	6	1	6
Dissociate Wt. & Vol.	8	9	8	72
Conserve Vol. (4)	4	9	4	36
Classes (5a)	1	6	1	6
Transfer 2D to 3D	4	4	4	16

[a] Max. 6 points on subtask 1; 7 points on subtasks 2, 3 and 4.

data were gathered from administration of the Piagetian reasoning assessments: pretraining, midtraining and posttraining. The project director administered the pretreatment and posttreatment Wechsler verbal scales (WISC or WAIS). Scores on the Warner's Index of Social Characteristics were determined in the Phase I study and were on file.

Testing required a minimum of three hours. The number of testing sessions varied in order to accomodate student schedules. In an effort to prevent the establishment of a response set, two similar experiments (for example, conservation of substance and conservation of volume) were not administered successively.

Social Interaction

One stated objective of the remediation system was to assess the individual subject's interaction with his environment through adaptation and extension of the Social Interaction Schedule (Kaufman, et al., 1973). During the first year of intervention, the social interaction of ten treatment subjects was observed. A staff member, trained in the use of interaction schedules, observed the subjects in their regularly scheduled classes.

The data gathered from the observation sessions served to suggest a predominance of teacher centered classroom behaviors with little pupil initiated interaction. Observation data served to suggest that the subjects spent a large proportion of their time reading or brailling. However, difficulty arose in determining which observed behaviors were related to personality characteristics of the blind, on the one hand, and to dominate factors in the environment, on the other. Also lacking were comparable data on partially sighted and sighted children. Based on these limitations determination was made that data gathered from the adapted observation schedule might produce erroneous conclusions. A need was identified for an instrument with demonstrated reliability and validity devoid of observer bias effects which may be better adapted to the situation. Hence, determination was made to discontinue observation sessions.

Data Analyses

Comparisons were made of pretreatment and posttreatment scores for blind treatment, blind nontreatment and sighted comparison groups. Midtraining data were utilized only in the internal system review process, i.e., to revise student profiles and modify the teacher training program. Measures of central tendency and dispersion were obtained on all pre- and posttreatment variables. Appropriate nonparametric statistics (Siegel, 1956) were employed on between - group (Mann-Whitney U Test) and within group comparisons (Wilcoxon Matched-Pairs Signed-Ranks Test).

It was deemed advisable in designing the present study to control for chronological age, IQ and sex across the three comparison groups. Hence, the groups were roughly matched on these characteristics. However, the matching was accomplished at the level of summary group statistics. It was not possible to establish a matching subject-by-subject on CA, IQ and sex. Since the number of blind students was severely limited, it was not possible, for example, to find a blind male subject age 7 years with IQ 96 to match a sighted subject of exactly the same type. Thus, although the three groups were balanced with respect to average CA, IQ and proportions of boys and girls, one can not establish matched triplets across the groups.

This design strategy, although sensible and defensible, creates some minor problems in statistical inference. The three groups thus formed are statistically dependent, in that, for example, the means of such groups across replicated samples would show non-zero correlation. However, it is impossible to assess the exact degree of dependence and take it into account in making statistical probability statements. Such statistical dependencies are always accounted for by building the analyses around matched pairs, triplets, etc., of subjects, an analysis which can not be made in this instance. Even though the significance levels in the Mann-Whitney tests are affected by this dependence to some unknown degree, we can be confident that we know the general direction of the affect of dependence. The dependence of the samples will surely make the U-tests more conservative than the apparent significance levels. Thus, any U-test that results in significance at the .05 level, for example, can be confidently regarded as significant at that level or one even stronger. Moreover, some U-tests that appear to be nonsignificant may actually be significant, if one only had some way of taking group dependence properly into account. These remarks apply to the

Mann-Whitney U Tests in Tables 1-8; they do not apply to the Wilcoxon signed-rank tests in Tables 9-10 where the dependence of a single group across time is properly accounted for.

Data collected in the teacher training subsystem was profiled to determine the needs of individual teachers and the effectiveness of training activities. Since the two teachers involved in the original preservice training workshop did not remain for the entire remediation period, partial data were collected on performance of the original two teachers and their replacements. As a result of the small sample size no statistical treatment was undertaken. However, the data did serve to direct training efforts and development of a training model. The application of the data is contained in The Teacher Training Manual for Teachers of the Visually Handicapped: A Piagetian Perspective.

Changes in Original Project Design

Changes in the original project design included: 1) reduction in sample size, 2) discontinuation of data collection on the Social Interaction Schedule, 3) use of nonparametric statistics, and 4) condensation of five proposed products into three.

These changes were documented in quarterly progress reports submitted to the Bureau of Education for the Handicapped.

CHAPTER III - RESULTS

Reasoning performance was analyzed for three groups: (1) blind treatment, (2) blind nontreatment, and (3) sighted nontreatment. Analyses included both between-group and within-group comparisons on pre- and posttest reasoning scores. Differences were considered to be significant if they occurred at $p \leq .05$ level. Tables 3-10 and Figures 1-10, which set forth the results of these analyses, begin on page 61.

Analyses of Pretest Scores

The Mann-Whitney U Test was utilized to determine whether significant differences existed between the two blind groups or between the sighted and blind groups. The p values were calculated from the standard normal approximation, based on the U statistic, corrected for ties. Results of these analyses are presented in Tables 3, 4 and 5.

Analysis of reasoning scores of blind and sighted subjects undertaken during the Phase I study (Stephens and Simpkins, 1974) served to indicate that the sighted subjects had significantly superior performance on 18 of 26 variables. Sighted and blind subjects assessed in the present study were drawn from the Phase I population. The pretest data were collected approximately 18 months after the Phase I assessment. When performance of the blind treatment group was compared to that of the sighted comparison group, significant differences were found to occur on 15 of the 26 variables (Table 3). On each task where significance was indicated, the sighted group had superior performance. There were 7 differences in the 10 concrete conservation tasks (Figures 1 and 2); 1 difference in the 6 classification tasks (Figure 3); 3 differences in the 4 mental imagery/spatial relations tasks (Figure 4); and 4 differences in the 6 abstract/formal operations task (Figure 5 and Table 3).

Comparison of the performance of the blind nontreatment group with the sighted comparison group served to indicate that significant differences favoring the sighted group occurred on 18 of the 26 variables (Table 4). There were 7 differences in the concrete conservation area (Figures 1 and 2); 3 differences in the mental imagery/spatial relations area (Figure 4); and 4 differences in the abstract/formal operations area (Figure 5).

Maturation which resulted in improved scores for all three groups was expected. Because the intellectual functioning of the blind subjects was equivalent to that of the sighted subjects on the verbal scale of the Wechsler Intelligence Scale (both groups were in the 90-110 IQ range), it was assumed that the potential for acquisition of "normal" reasoning ability was present, but that the experience required for its development had been lacking. Since the deficits in the assessment areas generally were considered to be remedial, it was posited that the subjects should eventually be able to overcome the lags in reasoning if appropriate activities were provided. While the total number of significant differences was similar, the level of significance had decreased. In the Phase I study the superior performance of the sighted subjects was evident on 18 of the 26 variables with 17 differences identified as significant at the $p \leq .01$ level. In the Phase II training assessment, comparison of performance of the sighted nontreatment group and the blind treatment group served to indicate only seven differences at the $p \leq .01$ significance level, and eight differences at the $p \leq .05$ significance level. The comparison of performances of the sighted group and the blind nontreatment group yielded 14 significant differences at the $p \leq .01$ level and four at the $p \leq .05$ level.

The mean scores for the sighted subjects exceeded those of the blind treatment and blind nontreatment subjects, except for scores obtained on three hierarchical classification tasks. The superior performance of the blind subjects on these tasks may be attributed to the fact that adaptations of the classification assessments for blind (hierarchical classification of real food) proved to be more elementary than the original version which required the sighted subjects to classify pictures of animals. Kohlberg (1963) suggests that classification of foods emerges before that of animals. Piaget (1971) has indicated that the age at which a child solves a problem can be delayed if one changes materials or situations.

When performance of the two blind groups was compared, only one significant difference was obtained (Table 5). The performance of the treatment group was superior at the $p = .046$ level on the mental imagery/spatial relations task, Rotation of Order Beads. The pretest data served to indicate that the two blind groups were approximately equivalent in performance prior to the onset of the intervention program. However, when comparisons of sighted and blind group performances were computed, it was evident that the severe deficits in reasoning exhibited by the blind subjects in the Phase I study continued to be evident in Phase II pretest data.

Analyses of Posttest Scores

When posttest performances of the sighted nontreatment group and the blind treatment group were compared, three significant differences were identified (Table 6). The superior performance of the sighted group was indicated on two mental imagery/spatial relations tasks (Rotation of Squares and Changing Perspectives - Stationary) and one abstract/formal operations task (Transfer from Two to Three Dimensions). The eight significant differences in reasoning which were identified in the pretest conservation and classification tasks were eliminated, and four of the seven differences in the mental imagery/spatial relations and abstract/formal operations tasks also were eliminated.

Posttest comparisons of the sighted comparison group and the blind nontreatment group yielded significant differences, with the sighted group demonstrating superior performance on 11 of the 26 variables (Table 7). The blind nontreatment group exhibited the greatest growth in the conservation area, reducing the number of pretest significant differences from 7 to 3. One difference was eliminated in each of the other three assessment areas.

A comparison of performance between the two blind groups on the posttest served to indicate that the treatment group had significantly superior performance on 15 of the 26 variables. Obtained differences are set forth in Table 8. Even though the blind nontreatment group had shown their greatest growth in the conservation area, as indicated in the posttest comparison with the sighted group, the posttest comparison of the two blind groups served to indicate that the treatment group had significantly superior performance on 7 of the 10 conservation tasks (Figure 6, Figure 7). Significant differences which served to indicate superior performance of the treatment group also were evident on three classification tasks (Figure 8), one mental imagery/spatial relations task (Figure 9), and four abstract/formal operations tasks (Figure 10). On Changing Perspectives-Stationary the sighted group had significantly superior performance when compared to the treatment group, and posttest comparison between the two blind groups served to indicate that the treatment group had significantly superior performance over the blind nontreatment group.

A pre- to posttest comparison was performed on data obtained from administration of assessments to the blind nontreatment group. The Wilcoxon matched-pairs signed-ranks test was used in the within-group comparison. The *p* values were calculated from the standard normal approximation. As indicated in Table 7, during the remediation period, the blind nontreatment group exhibited significant growth on only seven assessment tasks. Two significant differences were noted in each of the three concrete areas, while one significant difference was indicated in the formal/abstract area.

When similar comparison was performed on the pre- to posttest data of the treatment group, 22 significant differences were noted (Table 10). On the four tasks where significant growth was not shown two were mental imagery/spatial relations tasks (*Rotation of Beads* and *Rotation of Squares*) and two were classification assessments (*Intersection of Classes* and *Hierarchical Classification of Foods-5b*). On the task *Classification of Foods-5b*, the mean score of the treatment group was greater than both nontreatment groups (4.69 of a possible 6.0) on the pretest and further significant growth was difficult to achieve. Therefore, lack of change was not due to inability, but rather superior performance. The four tactually distinct designs utilized in the *Intersection of Classes* task were more abstract than the symbols employed in the sighted version. Reference is again made to Piaget's position (1971) that a change in material can affect the age at which the subject is able to solve a problem.

CHAPTER IV - CONCLUSION

The major objective of the project was to determine if reasoning deficits identified in congenitally blind persons could be ameliorated through the implementation of individually designed intervention activities. Present discussion provides review of the findings of the study and an examination of the practical and theoretical significance of these results.

When pretraining assessments of reasoning were administered to the (1) blind treatment group (2) blind nontreatment group and (3) sighted nontreatment group, the performance of the sighted group was significantly superior to that of the blind treatment group on 15 of the 26 variables and was significantly superior to the performance of the blind nontreatment group on 18 of the 26 variables.

However, when posttraining assessment scores were obtained after 17 months of individualized intervention, the treatment group's performance showed significant improvement. Significant deficits that had existed on the pretest comparison of blind treatment group and sighted control group performances were eliminated with only three exceptions. On 14 tasks the performance of the blind treatment group surpassed that of the sighted nontreatment group; however, since both groups had near maximum scores on 6 of the 14 tasks, the differences which did favor the blind treatment group were not significant on these 6 variables.

Posttest comparison of the blind nontreatment group and the sighted nontreatment group performances revealed continued maturational growth for both groups. However, when compared with the sighted nontreatment group the blind nontreatment group exhibited significant deficits on 11 of the 26 tasks. The blind nontreatment group had superior, but not significantly superior performance on two subscores of the hierarchial classification task; however, these differences were probably attributable to the fact that when this assessment was adapted for the blind the adapted version required a lower level of classificatory logic than was required in the original task which was administered to the sighted subjects. Over the 17 month intervention period, the blind nontreatment group exhibited significant growth on only 7 variables, while the treatment group exhibited significant growth on 22 of the 26 variables. The posttest comparison of the blind treatment group and blind nontreatment group performances served to indicate significantly superior performance by the treatment group on 15 of 26 tasks.

The data served to indicate that blind subjects, when offered developmentally appropriate experience in reasoning, can function at a level equivalent with their sighted peers. A review of the assessment results in each of the four task areas follows.

Conservation

Mastery of concrete conservation concepts is usually attained by sighted children between the ages of 7 and 11 years. When performance of the group of sighted subjects was compared to the performances of the two groups of blind subjects prior to treatment, the sighted nontreatment group had significantly superior performance on 7 of the 10 conservation tasks. These findings are consistent with those reported by Friedman and Pasnak (1973) and by Tobin (1972).

If the blind overcome some deficits through maturation, two questions persist: 1) can the blind student overcome all of the conservation deficits, and 2) if not, can the deficits be ameliorated at a point in time that would permit the visually handicapped student to maintain the conceptual progress evidenced in sighted students? Miller (1969) suggested that older blind subjects might be unable to eliminate deficits in conservation. Following the intervention program, the treatment group had eliminated deficits in the conservation area. Comparison of scores for the blind nontreatment group with those for the sighted group revealed three significant differences favoring the sighted group: these were on the tasks _One for One Exchange_, _Conservation of Length_, and _Conservation of Volume_ (1-3). Although the conservation deficits can be remediated, maturation alone does not permit the visually handicapped to overcome the deficits within the "normal" sighted acquisition period in which they generally are achieved in sighted persons, i.e., 7-11 years. The success of the remediation effort is evident when comparison is made of performances of the two blind groups on the conservation tasks. After training, the blind treatment group had significantly superior performance on 7 of the 10 assessments that measured concrete level conservation when compared to the performance of the blind nontreatment group. They did not have statistically superior performance on Conservation of Substance, Weight, and Rod Sections. These data serve to support findings reported by Lapata and Pasnak (1976), findings which indicate that training can improve performance in areas involving Conservation of Substance.

An overview of the Piagetian theoretical approaches to various curriculum areas has been included in the literature review. The necessary concepts for success at a given grade level is dependent upon the curriculum area and the context. However, certain basic conservation concepts which relate to elementary math tasks are prerequisites for higher level math courses. Reversibility of thought is essential for understanding inverse computational problems. Moreover, conservation of number, length, area, and mass are basic to the child's understanding of the world around him. When a child without the conceptual foundation compensates through rote memorization of details, he has not established the basis for higher conceptual learning.

Classification

Prior to the implementation of the intervention program, both visually handicapped groups exhibited a significant deficit on the task Class Inclusion (Beads). In addition, the nontreatment blind group had significant deficits on a classification task that required addition of classes and on a task that required grouping and regrouping of objects on more than one criterion. On the posttest comparison of assessment scores with the sighted group, no significant deficits were evident for the treatment group, while two deficits remained for the nontreatment group.

Two factors should be considered in the interpretation of these data, 1) there was a natural ongoing maturational increase over the two-year period, and 2) adaptation of the Classification (Foods Assessments) provided tasks that were less demanding than the tasks originally administered to the sighted group.

It is evident that maturation processes alone will not assure sufficient experiences for the blind to overcome all of the classification deficits. The blind require opportunities to classify, group and regroup objects and events, and to deal with more than one quality or property of an object. Stephens and Simpkins (1974) and Hatwell (1966) posited that the blind, as a result of receiving input primarily through the tactual mode, lack the required figurative simultaneity that the sighted receive through visual input. Their success in the adapted task involving classification of foods probably can be attributed to the fact that they were sorting foods, objects that are in their every day environment; whereas, the original version which was administered to the sighted required the sorting of animals most of which were not in the child's immediate surroundings.

The comparison of posttest performance revealed that the treatment group's performance was significantly superior on three of the classification tasks when compared to the nontreatment blind group. This further supports the basic tenets of the remediation program, i.e., that the blind can perform on a par with their sighted peers. The disadvantages that result from deficient classification skills are numerous. In academic areas, difficulties might arise in understanding mathematic set theory and number relations, the organization and integration of nation and state concepts in social studies, and the physical relationships or properties of objects confronted in vocational education classes. While the degree of dependency on classification skills varies as a factor of grade level and academic area, consideration must be given to the fact that when the student does not have the conceptual basis for understanding material presented in the classroom, the ensuing conceptual structures will be developed at a slower rate.

Mental Imagery/Spatial Relations

Data from the Stephens and Simpkins (1974) study served to indicate that the blind improve little in the area of mental imagery and spatial relations between the years of 6 to 18. On the Phase II pretest comparison of performances of the blind groups with the sighted group, the treatment group had significant deficits on three of the four assessment tasks, while the nontreatment blind group had deficits on all four tasks. The master teachers who prepared activities to remediate specific deficits in this area found it difficult to comprehend the congenitally blind students' perception of mental images, i.e., how does the tactual representation of objects by the blind correspond to the visual representation of objects by the sighted? Activities were similar to those developed for use with sighted children. Tasks differed in that the materials were selected to permit greater tactual interaction and to reduce requirements so that the tasks would start at the level at which the severe deficits occurred in this area. Traditionally the terminology employed in mental imagery activities had visual referents. The visually handicapped subjects were required to translate the information into a schema compatible with the limitation imposed by the sensory deficit. The accommodation system employed by the congenitally blind child is not readily discernible by a sighted person. Whether there is consistency in the accommodation system of one visually handicapped individual as compared to another remains to be determined; additional research is needed in this area.

The posttest results served to indicate that significant deficits remained on two mental imagery and spatial orientation tasks for the treatment group, and on three tasks for the nontreatment group. The one task on which the nontreatment group showed growth, Rotation of Order (Beads), is usually accomplished by the sighted in the early concrete operational stage. When comparison of performance of the blind treatment group and the sighted nontreatment group was made after the training period, differences between the two groups were no longer significant on the task Changing Perspectives (Mobile). The fact that the treatment group had significantly superior performance on the stationary portion of the perspectives task when compared to the nontreatment blind group served to indicate that the remediation was beneficial.

When subjects performance was reviewed on the three tasks that involve spatial relations/mental imagery, there was note that generally there was acceptable performance on a task that required emerging or low level ability in this area. The initial task required the assessor and student to insert a wire with three beads into a tube. The tube was then rotated and the subject had to predict which of the three would emerge first. Generally successful performance was noted by a majority of subjects on this task. A decrement was noted in a succeeding task that required more advanced performance in this area. Little success was noted in a subsequent task that demanded still more advanced performance. The subject was required to imagine the placement of objects when approached from a direction other than the one he was in at that time.

Because the blind subjects generally evidenced success on the initial task, there is suggestion that the ability to perform in the area of spatial orientation and mental imagery probably could be extended if opportunity is provided for experiences which draw on the intact functioning of the blind person as it circumvents his sensory impairment.

Data from the present study serve to support data from previous studies in the suggestion that the visual modality in spatial relations/mental imagery is more significant than originally hypothesized. Adelson and Fraiberg (1974) noted that early intervention does not completely eliminate delays and deficits in spatial orientation. In her experience in training blind persons, Barraga (1976) found that the establishment of spatial orientation was a long and tedious process. Schmid-Kitsikis (1974) posited that age of onset of blindness was related to the degree of deficits in spatial relationships. Swallow's (1973) work served to emphasize the spatial impairment that characterizes the performance of blind pupils.

While the activities employed in the present study did promote some growth in this area, it is unlikely that more rapid progress can be accomplished without a greater understanding of the congenitally blind child's "compensation system." It is possible that efforts to guide the child's spatial experiences in the early sensory motor period would provide needed information on how to deal more effectively with mental imagery/spatial relations deficits.

Formal - Abstract Operation

The pretest data served to indicate that both visually handicapped groups had significant deficits on four of six formal level tasks when their scores were compared with the sighted group. These deficits were anticipated because the performances of the visually handicapped groups were deficient in the prerequisite areas of classification and conservation. Activities were provided those students who were developmentally ready for the tasks, i.e., a 7 or 8 year old child was not presented formal level activities, even though he did not succeed on assessments designed to measure his level of functioning in this area.

The posttest results served to indicate that the blind treatment group's performance was deficient on one assessment task, Transfer from Two to Three Dimensions. Mastery on this task is usually not achieved by sighted persons until post-high school years. There also is a strong visual component in the original task that apparently does not translate to performance based on a tactual component.

The nontreatment group had three significant deficits on formal level assessments when their performance was compared to the performance of the sighted group. These were on the tasks, Combinations of Liquids, Dissolution of Sugar (Volume) and, Transfer from Two to Three Dimensions. The superior performance of the treatment group was evident in two comparisons: 1) when compared to the blind nontreatment group the treatment group had significantly superior performance on four of the six formal tasks, and 2) the treatment group had superior but not significantly superior performance on four tasks when their scores were compared to the sighted nontreatment group. These data served to indicate that the treatment group's performance was equivalent to the performance of the sighted group on 23 variables and on 14 of these variables the treatment group had performance superior to that of the sighted group on those tasks not heavily dependent upon the visual modality, e.g., Term to Term Correspondence, Conservation of Liquid, Classification of Food (5a), and Conservation of Weight.

Since the ability to reason at the abstract level is related to success in higher level math (algebra), science, and social studies (Lawson, 1975; Hallam, 1969), there is suggestion that the visually handicapped student should benefit academically from improved formal level reasoning skills.

Summary

While maturational growth was an ongoing variable to be considered in the data analyses, the superior performance of the treatment group (in comparison to the nontreatment blind group's performance), suggests that the intervention program significantly enhanced the treatment group's reasoning development. It is acknowledged that there were several variables operating within the intervention program that contributed to the increase in reasoning scores. These included (1) the remediation activities, (2) the process oriented approach implemented by the teacher, and (3) the general increase in social interaction derived from pupil-teacher contact. Although it was not possible to ascertain the degree of importance of each variable, Piaget has stressed the need for both social and material interaction before normal cognitive potential can be realized. This intervention program was designed to realize the maximum benefit from such interaction. Thus, effective replication of the program would of necessity include not only activities that provide opportunity for interaction, but also teachers trained to guide student involvement and to provide situations which foster disequilibrium.

Failure to address the reasoning deficits exhibited by congenitally blind children proceeds to make inability in reasoning a second handicapping condition which further hinders the blind child's comprehension of his environment. The development of programs to meet the blind child's reasoning needs is consistent with mandates established by Public Law 94-142.

Findings from the present study that may be viewed as contributions in the area of the visually handicapped and also to developmental psychology and pedagogy include:

1) data which demonstrate that visually handicapped persons ages 6-18, IQ 90-110, have severe deficits in reasoning,

2) that deficits in these persons are amenable to individually appropriate remediation,

3) that a method which emphasizes a process oriented approach promotes significant growth in reasoning,

4) that deficits in spatial orientation and mental imagery are not as successfully ameliorated as are deficits in other areas of reasoning.

Products which issue from the study are: Student Activity Guide: A Piagetian Perspective and the Training Manual for Teachers of the Visually Handicapped: A Piagetian Perspective.

Chapter V - Recommendations

Based on the needs of the visually handicapped population identified by Stephens and Simpkins (1974) and the resultant (Phase II) successful intervention program, the following recommendations and suggestions for their implementation are offered:

(1) To meet the demands of Public Law 94-142, specifically that individual educational programs (IEP) be provided to all handicapped students, there is need for individual appraisal in the various developmental areas. The Piagetian assessments utilized in this study provide detailed appraisal of pupils' cognitive level of functioning at the elementary and secondary levels. Therefore recommendation is made that they be included with other instruments that provide the basis for information used in planning the IEP.

(2) The program should incorporate methods that demand activity on the part of the pupil and emphasize the process rather than the products of his thoughts. In order to establish these skills teachers should be trained to:

   (a) assess the reasoning abilities of their visually handicapped students.

   (b) prepare individual educational plans (IEP) that address the needs of the student as identified on the student assessment profile.

   (c) develop activities which encourage social and material interaction.

(3) Findings from the present study served to indicate that reasoning deficits of the congenitally blind can be reduced through a remediation program; however, the ultimate goal should focus on early prevention of deficits rather than remediation. To accomplish this goal, there is need for extensive inservice training to prepare existing classroom teachers, particularly those in the area of early education, to use process oriented

teaching strategies.

(4) To understand the effects of blindness on the development of reasoning, research must be designed which focuses on the following areas:

    (a) the visually handicapped child's understanding and processing of mental imagery concepts which are associated with and directly related to the visual modality.

    (b) the role of spatial relations activities in the teaching of mobility skills.

    (c) comparison of interaction (social and material) observed in residential school classrooms with regular day school classrooms.

    (d) a longitudinal effort to examine the effects of interaction experiences with children in the preschool years (birth to 5 years).

    (e) the determination of the degree of importance of social interaction vs. material interaction.

(5) An intervention program should be implemented with sighted children to determine the effect of added interaction experiences on their reasoning development.

(6) Studies should be conducted to determine whether there is a correlation between improvement in reasoning scores and improvement in academic skills for those students participating in intervention programs.

(7) Correlational studies should be undertaken to determine whether improvement in reasoning scores effects IQ scores.

(8) A longitudinal study should be undertaken to determine the long-term benefits of reasoning intervention programs upon the curricular and extracurricular performances of the blind.

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TABLE 3

PRETRAINING COMPARISON OF REASONING POINT SCALE SCORES FOR SIGHTED NONTREATMENT SUBJECTS (N=13) AND BLIND TREATMENT SUBJECTS (N=13) THROUGH USE OF MANN-WHITNEY U TEST

	Sighted Nontreatment $\bar{X}$	Blind Treatment $\bar{X}$	2-Tailed Significance Value p
One for One Exchange	11.92	10.69	.004
Term to Term Correspondence	26.38	22.85	.012
Conservation of Liquid	20.85	15.77	.047
Conservation of Length	20.15	13.00	.005
Conservation of Length (Rods)	21.00	17.77	.015
Conservation of Substance	20.62	16.00	.032
Dissolution of Sugar (Subst.)	9.77	7.77	.152
Dissolution of Sugar (Wt.)	9.46	7.08	.129
Conservation of Weight	19.46	14.54	.103
Conservation of Volume (1-3)	15.77	7.62	.006
Intersection of Classes	20.38	19.46	.392
Class Inclusion (Beads)	3.62	2.15	.033
Classification of Foods (3)	19.54	16.77	.062
Classification of Foods (4)	27.31	28.77	.468
Classification of Foods (5b)	3.92	4.69	.496
Changing Criterion	2.69	2.38	.344
Rotation of Beads	22.85	22.15	.538
Rotation of Squares	4.23	2.77	.023
Changing Perspectives (Mobile)	34.08	16.38	.002
Changing Perspectives (Stationary)	37.46	21.92	.004
Combination of Liquids (Chemistry)	2.92	2.38	.050
Dissolution of Sugar (Vol.)	3.69	2.38	.110
Dissociation of Weight and Volume	40.23	23.85	.006
Conservation of Volume (4)	16.31	6.15	.032
Classification of Foods (5a)	2.69	3.00	.704
Transfer from Two to Three Dimensions	11.38	7.46	.000

TABLE 4

PRETRAINING COMPARISON OF REASONING POINT SCALE SCORES FOR SIGHTED NONTREATMENT SUBJECTS (N=13) AND BLIND NONTREATMENT SUBJECTS (N=13) THROUGH USE OF MANN-WHITNEY U TEST

	Sighted Nontreatment $\bar{X}$	Blind Nontreatment $\bar{X}$	2-Tailed Significance Value p
One for One Exchange	11.92	9.08	.001
Term to Term Correspondence	26.38	20.46	.004
Conservation of Liquid	20.85	13.46	.008
Conservation of Length	20.15	8.08	.000
Conservation of Length (Rods)	21.00	17.15	.072
Conservation of Substance	20.62	15.23	.052
Dissolution of Sugar (Subst.)	9.77	7.77	.096
Dissolution of Sugar (Wt.)	9.46	4.85	.004
Conservation of Weight	19.46	12.92	.003
Conservation of Volume (1-3)	15.77	8.46	.017
Intersection of Classes	20.38	17.23	.084
Class Inclusion (Beads)	3.62	.92	.000
Classification of Foods (3)	19.54	14.31	.030
Classification of Foods (4)	27.31	28.38	.534
Classification of Foods (5b)	3.92	4.23	.915
Changing Criterion	2.69	1.85	.007
Rotation of Beads	22.85	18.38	.016
Rotation of Squares	4.23	2.38	.002
Changing Perspectives (Mobile)	34.08	13.69	.000
Changing Perspectives (Stationary)	37.46	13.69	.000
Combination of Liquids (Chemistry)	2.92	2.31	.024
Dissolution of Sugar (Vol.)	3.69	1.54	.007
Dissociation of Weight and Volume	40.23	23.92	.006
Conservation of Volume (4)	16.31	6.85	.196
Classification of Foods (5a)	2.69	2.23	.910
Transfer from Two to Three Dimensions	11.38	5.69	.000

TABLE 5

PRETRAINING COMPARISON OF REASONING POINT SCALE SCORES FOR BLIND NONTREATMENT SUBJECTS (N=13) AND BLIND TREATMENT SUBJECTS (N=13) THROUGH USE OF MANN-WHITNEY U TEST

	Blind Nontreatment $\bar{X}$	Blind Treatment $\bar{X}$	2-Tailed Significance Value p
One for One Exchange	9.08	10.69	.246
Term to Term Correspondence	20.46	22.86	.301
Conservation of Liquid	13.46	15.77	.500
Conservation of Length	8.08	13.00	.149
Conservation of Length (Rods)	17.15	17.77	.510
Conservation of Substance	15.23	16.00	.956
Dissolution of Sugar (Subst.)	7.77	7.77	.979
Dissolution of Sugar (Wt.)	4.85	7.08	.128
Conservation of Weight	12.92	14.54	.417
Conservation of Volume (1-3)	8.46	7.62	.913
Intersection of Classes	17.23	19.46	.270
Class Inclusion (Beads)	.92	2.15	.088
Classification of Foods (3)	14.31	16.77	.367
Classification of Foods (4)	28.38	28.77	.917
Classification of Foods (5b)	4.23	4.69	.350
Changing Criterion	1.85	2.38	.100
Rotation of Beads	18.38	22.15	.046
Rotation of Squares	2.38	2.77	.644
Changing Perspectives (Mobile)	13.69	16.38	.875
Changing Perspectives (Stationary)	13.69	21.92	.067
Combination of Liquid	2.31	2.38	.899
Dissolution of Sugar (Vol.)	1.54	2.38	.270
Dissociation of Weight and Volume	23.92	23.95	.568
Conservation of Volume (4)	6.85	6.15	.180
Classification of Foods (5a)	2.23	3.00	.802
Transfer from Two to Three Dimensions	5.69	7.46	.098

TABLE 6

POSTTRAINING COMPARISON OF REASONING POINT SCALE SCORES FOR SIGHTED NONTREATMENT SUBJECTS (N=13) AND BLIND TREATMENT SUBJECTS (N=13) THROUGH USE OF MANN-WHITNEY U TEST

	Sighted Nontreatment $\bar{X}$	Blind Treatment $\bar{X}$	2-Tailed Significance Value p
One for One Exchange	11.62	11.62	.613
Term to Term Correspondence	25.69	26.62	.173
Conservation of Liquid	20.46	20.77	.548
Conservation of Length	20.23	20.38	.654
Conservation of Length (Rods)	20.77	20.92	.518
Conservation of Substance	20.62	20.31	.550
Dissolution of Sugar (Subst.)	11.15	10.92	.615
Dissolution of Sugar (Wt.)	9.85	9.62	.886
Conservation of Weight	20.23	20.38	.945
Conservation of Volume (1-3)	16.85	18.38	.486
Intersection of Classes	21.77	21.00	.737
Class Inclusion (Beads)	3.77	3.54	.307
Classification of Foods (3)	20.46	21.69	.464
Classification of Foods (4)	26.54	33.62	.355
Classification of Foods (5b)	4.38	5.31	.202
Changing Criterion	2.92	3.00	.317
Rotation of Beads	23.54	21.46	.265
Rotation of Squares	5.31	3.38	.003
Changing Perspectives (Mobile)	35.38	26.15	.072
Changing Perspectives (Stationary)	40.62	30.77	.031
Combination of Liquids (Chemistry)	3.08	2.92	.644
Dissolution of Sugar (Vol.)	4.00	4.08	.956
Dissociation of Weight and Volume	42.92	47.38	.538
Conservation of Volume (4)	16.15	19.00	.511
Classification of Foods (5a)	3.62	4.85	.170
Transfer from Two to Three Dimensions	11.46	9.08	.007

TABLE 7

POSTTRAINING COMPARISON OF REASONING POINT SCALE SCORES FOR SIGHTED NONTREATMENT SUBJECTS (N=13) AND BLIND NONTREATMENT SUBJECTS (N=13) THROUGH USE OF MANN-WHITNEY U TEST

	Sighted Nontreatment $\overline{X}$	Blind Nontreatment $\overline{X}$	2-Tailed Significance Value p
One for One Exchange	11.62	10.00	.010
Term to Term Correspondence	25.69	24.46	.330
Conservation of Liquid	20.46	15.62	.056
Conservation of Length	20.23	12.15	.004
Conservation of Length (Rods)	20.77	17.00	.158
Conservation of Substance	20.62	17.31	.079
Dissolution of Sugar (Subst.)	11.15	8.77	.051
Dissolution of Sugar (Wt.)	9.85	6.46	.061
Conservation of Weight	20.23	17.85	.084
Conservation of Volume (1-3)	16.85	11.00	.032
Intersection of Classes	21.77	19.15	.141
Class Inclusion (Beads)	3.77	1.85	.007
Classification of Foods (3)	20.46	16.08	.012
Classification of Foods (4)	26.54	31.23	.733
Classification of Foods (5b)	4.38	4.77	.890
Changing Criterion	2.92	2.54	.064
Rotation of Beads	23.54	22.08	.379
Rotation of Squares	5.31	2.54	.000
Changing Perspectives (Mobile)	35.38	18.38	.002
Changing Perspectives (Stationary)	40.62	20.23	.000
Combination of Liquids (Chemistry)	3.08	2.08	.000
Dissolution of Sugar (Vol.)	4.00	1.92	.021
Dissociation of Weight and Volume	42.92	30.38	.054
Conservation of Volume (4)	16.15	10.31	.170
Classification of Foods Class Inclusion (5a)	3.62	3.08	.526
Transfer from Two to Three Dimensions	11.46	6.92	.000

TABLE 8

POSTTRAINING COMPARISON OF REASONING POINT SCALE SCORES FOR BLIND NONTREATMENT SUBJECTS (N=13) AND BLIND TREATMENT SUBJECTS (N=13) THROUGH USE OF MANN-WHITNEY U TEST

	Blind Nontreatment $\bar{X}$	Blind Treatment $\bar{X}$	2-Tailed Significance Value p
One for One Exchange	10.00	11.62	.009
Term to Term Correspondence	24.46	26.62	.028
Conservation of Liquid	15.62	20.77	.020
Conservation of Length	12.15	20.38	.002
Conservation of Length (Rods)	17.00	20.92	.056
Conservation of Substance	17.31	20.31	.204
Dissolution of Sugar (Subst.)	8.77	10.92	.031
Dissolution of Sugar (Wt.)	6.46	9.62	.049
Conservation of Weight	17.85	20.38	.100
Conservation of Volume (1-3)	11.00	18.38	.012
Intersection of Classes	19.15	21.00	.250
Class Inclusion (Beads)	1.85	3.54	.049
Classification of Foods (3)	16.08	21.69	.001
Classification of Foods (4)	31.23	33.62	.124
Classification of Foods (5b)	4.77	5.31	.176
Changing Criterion	2.54	3.00	.015
Rotation of Beads	22.08	21.46	.823
Rotation of Squares	2.54	3.38	.128
Changing Perspectives (Mobile)	18.38	26.15	.072
Changing Perspectives (Stationary)	20.23	30.77	.027
Combination of Liquids (Chemistry)	2.08	2.92	.009
Dissolution of Sugar (Vol.)	1.92	4.08	.018
Dissociation of Weight and Volume	30.38	47.38	.045
Conservation of Volume (4)	10.31	19.00	.051
Classification of Foods (5a)	3.08	4.85	.048
Transfer from Two to Three Dimensions	6.92	9.08	.052

TABLE 9

PRETRAINING-POSTTRAINING COMPARISON OF REASONING POINT SCALE SCORES FOR BLIND NONTREATMENT SUBJECTS (N=13) THROUGH USE OF WILCOXON MATCHED PAIRS SIGNED-RANKS TEST

	Pretraining $\bar{X}$	Posttraining $\bar{X}$	2-Tailed Significance Value p
One for One Exchange	9.08	10.00	.110
Term to Term Correspondence	20.46	24.46	.023
Conservation of Liquid	13.46	15.62	.249
Conservation of Length	8.08	12.15	.107
Conservation of Length (Rods)	17.15	17.00	.787
Conservation of Substance	15.23	17.31	.673
Dissolution of Sugar (Subst.)	7.77	8.77	.103
Dissolution of Sugar (Wt.)	4.85	6.46	.124
Conservation of Weight	12.92	17.85	.025
Conservation of Volume (1-3)	8.46	11.00	.208
Intersection of Classes	17.23	19.15	.214
Class Inclusion (Beads)	.92	1.85	.106
Classification of Foods (3)	14.31	16.08	.114
Classification of Foods (4)	28.38	31.23	.021
Classification of Foods (5b)	4.23	4.77	.500
Changing Criterion	1.85	2.54	.078
Rotation of Beads	18.38	22.08	.017
Rotation of Squares	2.38	2.54	.753
Changing Perspectives (Mobile)	13.69	18.38	.120
Changing Perspectives (Stationary)	13.69	20.23	.019
Combination of Liquids (Chemistry)	2.31	2.08	.109
Dissolution of Sugar (Vol.)	1.54	1.92	.500
Dissociation of Weight and Volume	23.92	30.38	.053
Conservation of Volume (4)	6.85	10.31	.109
Classification of Foods (5a)	2.23	3.08	.208
Transfer from Two to Three Dimensions	5.69	6.92	.025

TABLE 10

PRETRAINING-POSTTRAINING COMPARISON OF REASONING POINT SCALE SCORES FOR BLIND TREATMENT SUBJECTS (N=13) THROUGH USE OF WILCOXON MATCHED PAIRS SIGNED-RANKS TEST

	Pretraining $\overline{X}$	Posttraining $\overline{X}$	2-Tailed Significance Value p
One for One Exchange	10.69	11.62	.028
Term to Term Correspondence	22.85	26.62	.005
Conservation of Liquid	15.77	20.77	.043
Conservation of Length	13.00	20.38	.012
Conservation of Length (Rods)	17.77	20.92	.043
Conservation of Substance	16.00	20.31	.028
Dissolution of Sugar (Subst.)	7.77	10.92	.006
Dissolution of Sugar (Wt.)	7.08	9.62	.050
Conservation of Weight	14.54	20.38	.021
Conservation of Volume (1-3)	7.62	18.38	.004
Intersection of Classes	19.46	21.00	.176
Class Inclusion (Beads)	2.15	3.54	.028
Classification of Foods (3)	16.77	21.69	.003
Classification of Foods (4)	28.77	33.62	.002
Classification of Foods (5b)	4.69	5.31	.138
Changing Criterion	2.38	3.00	.043
Rotation of Beads	22.15	21.46	.314
Rotation of Squares	2.77	3.38	.248
Changing Perspectives (Mobile)	16.38	26.15	.034
Changing Perspectives (Stationary)	21.92	30.77	.046
Combination of Liquids (Chemistry)	2.38	2.92	.028
Dissolution of Sugar (Vol.)	2.38	4.08	.018
Dissociation of Weight and Volume	23.85	47.38	.002
Conservation of Volume (4)	6.15	19.00	.008
Classification of Foods (5a)	3.00	4.85	.046
Transfer from Two to Three Dimensions	7.46	9.08	.008

ASSESSMENT TASKS ABBREVIATION KEY
FOR FIGURES 1-10

Task Name	Abbreviated Task Name
One for One Exchange	1-1
Term to Term Correspondence	Term
Conservation of Liquid	Con. Liq.
Conservation of Length	Con. Len.
Conservation of Length (Rods)	Rod. Sec.
Conservation of Substance	Con. Sub.
Dissolution of Sugar (Subst.)	Sugar Sub.
Dissolution of Sugar (Wt.)	Sugar Wt.
Conservation of Weight	Con. Wt.
Conservation of Volume (1-3)	Con. Vol.
Intersection of Classes	Inters.
Class Inclusion (Beads)	Beads
Classification of Foods (3)	Class. (3)
Classification of Foods (4)	Class. (4)
Classification of Foods (5b)	Class. (5b)
Changing Criterion	Ch. Crit.
Rotation of Beads	Bd. Rot.
Rotation of Squares	Sq. Rot.
Changing Perspectives (Mobile)	Per. Mob.
Changing Perspectives (Stationary)	Per. Stat.
Combination of Liquids (Chemistry)	Chem.
Dissolution of Sugar (Vol.)	Sugar Vol.
Dissociation of Weight and Volume	Wt. & Vol.
Conservation of Volume (4)	Con. Vol. (4)
Classification of Foods (5a)	Class. (5a)
Transfer from Two to Three Dimensions	2 - 3 D

Figure 1

PRE-TREATMENT CONSERVATION SCORES

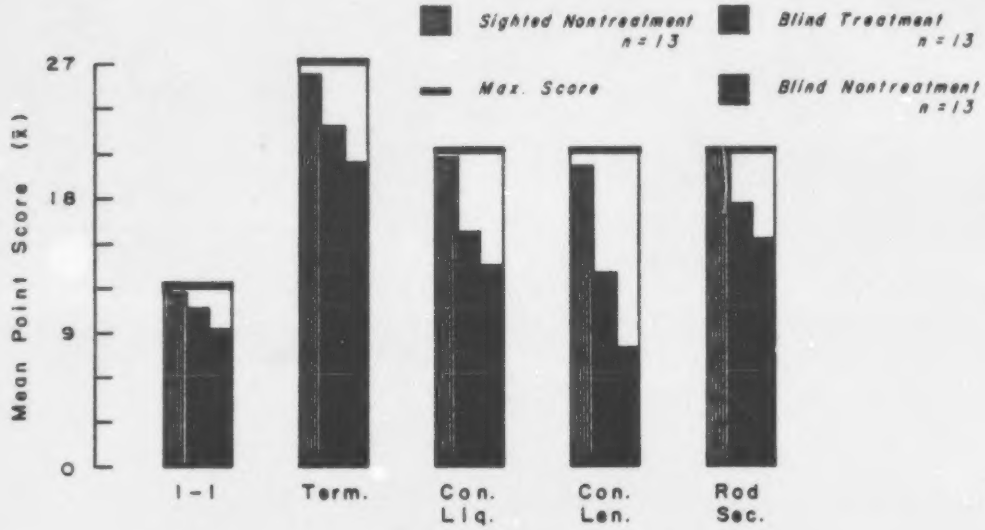


Figure 2

PRE-TREATMENT CONSERVATION SCORES

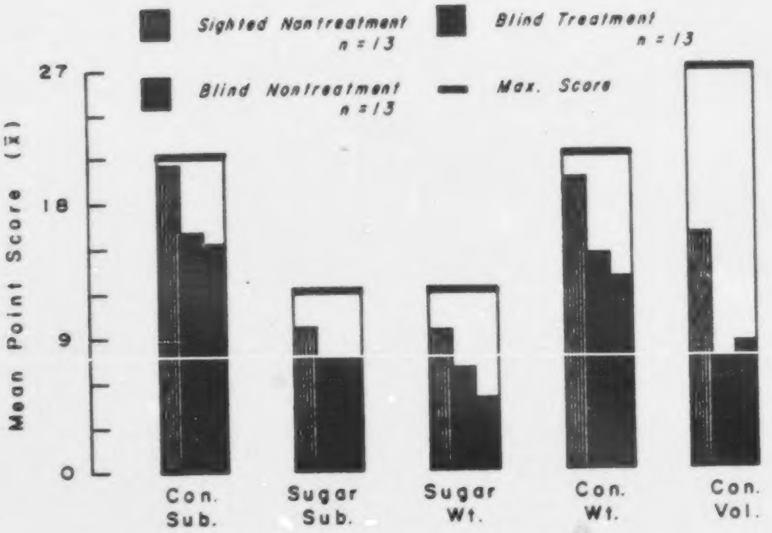


Figure 3

PRE-TREATMENT CLASSIFICATION SCORES

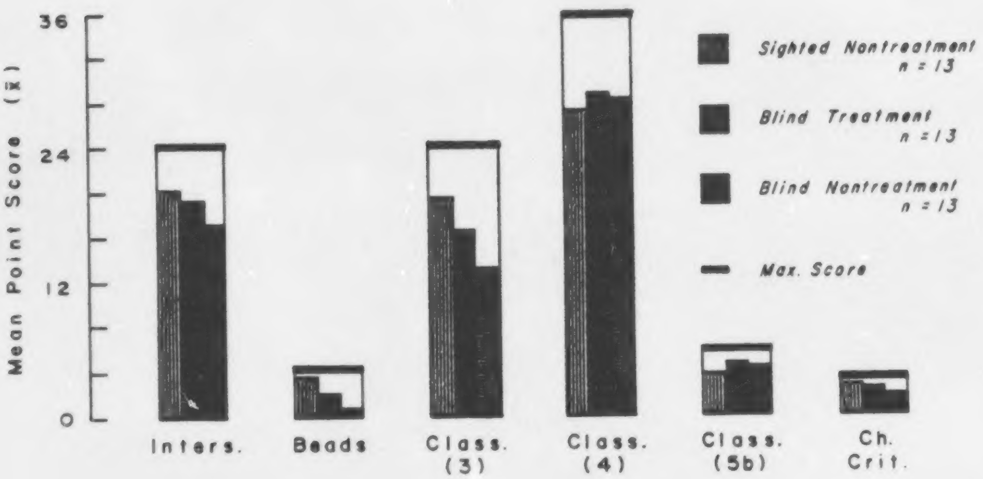


Figure 4

PRE-TREATMENT MENTAL IMAGERY/SPATIAL RELATIONS SCORES

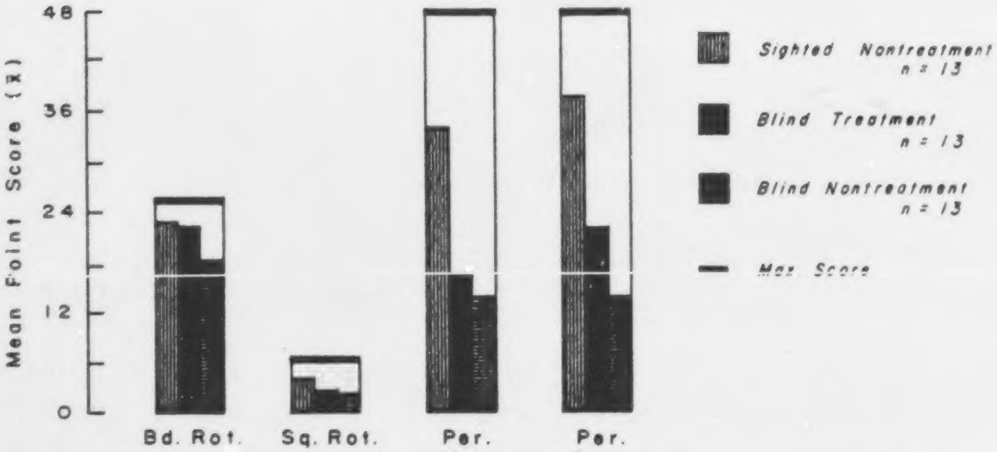


Figure 5

PRE-TREATMENT ABSTRACT/FORMAL OPERATIONS SCORES

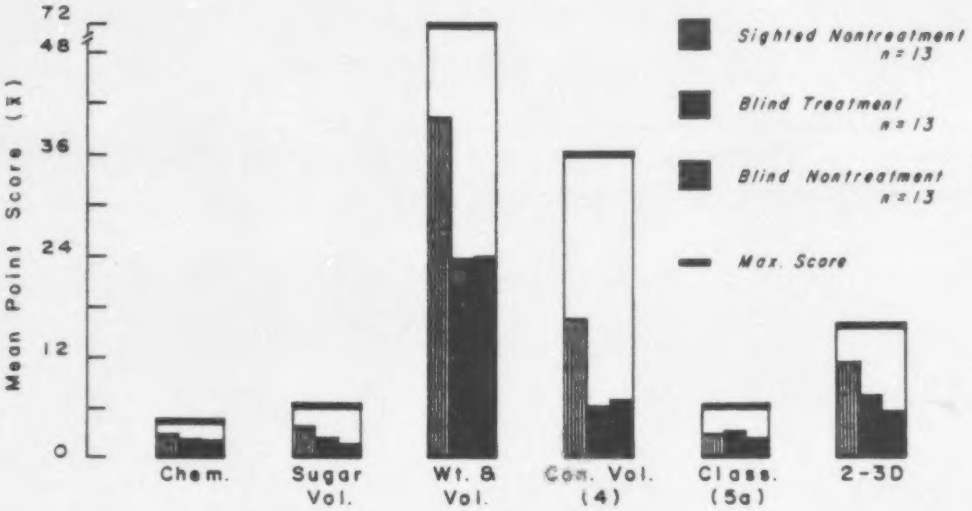


Figure 6

POST-TREATMENT CONSERVATION SCORES

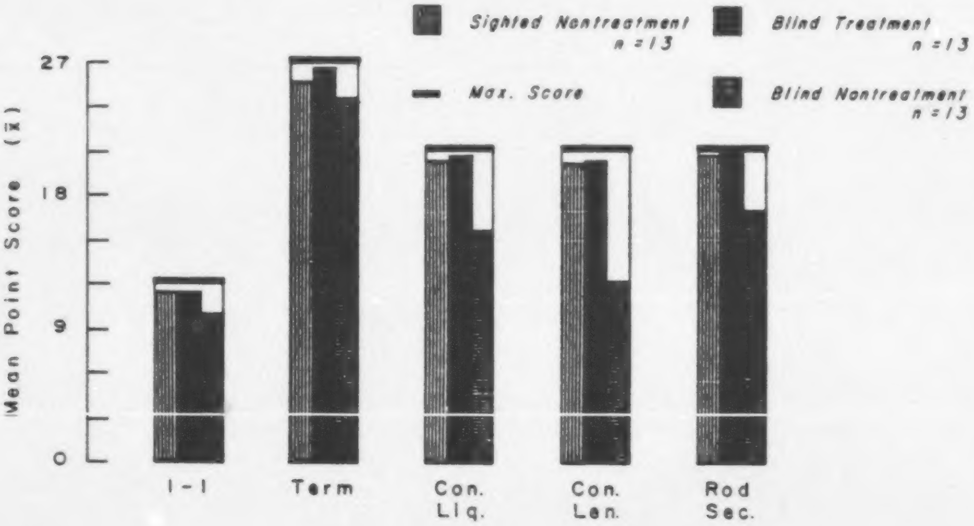


Figure 7

POST-TREATMENT CONSERVATION SCORES

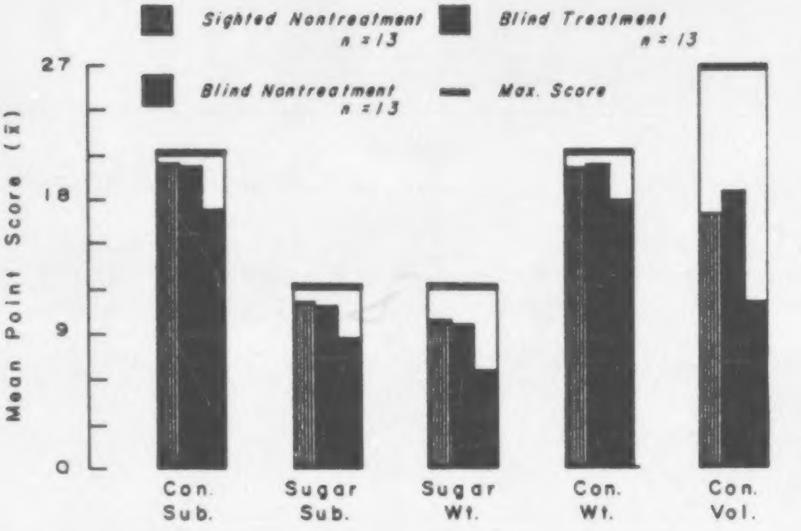


Figure 8

POST-TREATMENT CLASSIFICATION SCORES

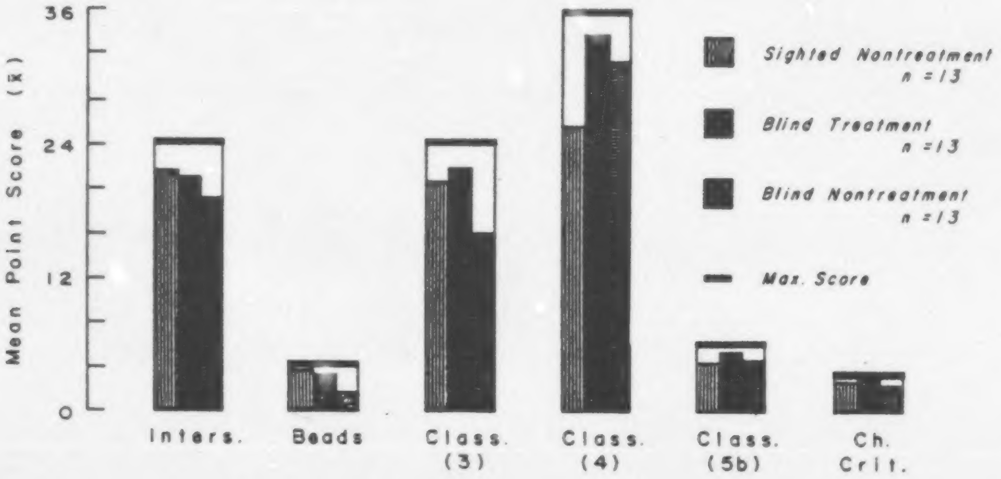


Figure 9

POST-TREATMENT MENTAL IMAGERY/SPATIAL RELATIONS SCORES

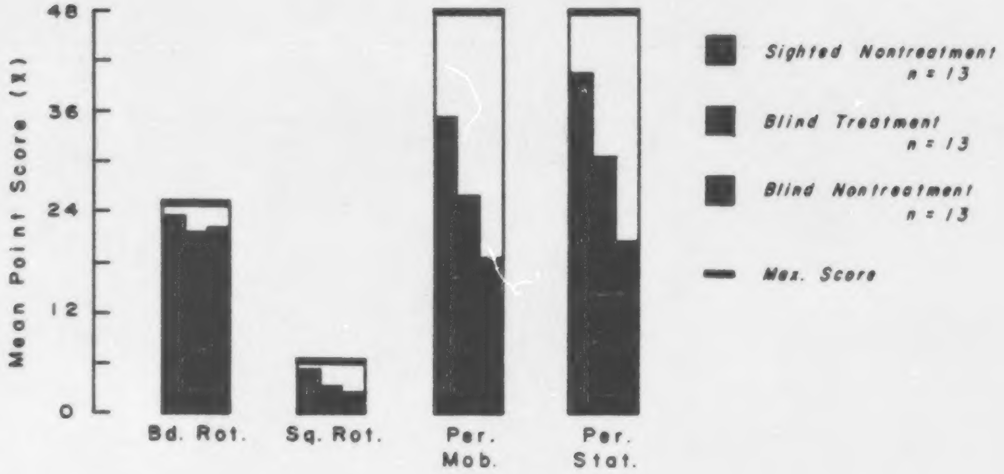
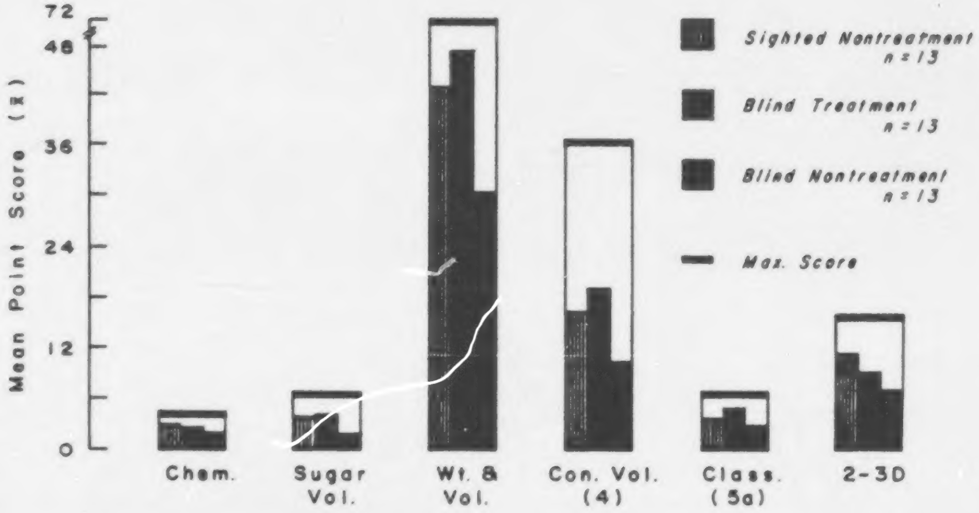


Figure 10

POST-TREATMENT ABSTRACT/FORMAL OPERATIONS SCORES



APPENDIX

Professional Staff

The professional staff that contributed to the research and publication efforts included:

Beth Stephens	Principal Investigator
Jo Hitt	Project Director
Carl Grube	Research Scientist
Eleanor H. Magnuson	Administrative Assistant
Joseph R. Fitzgerald	Master Teacher/Research Assoc.
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Barbara Dorwood	Consultant - Atlanta, Georgia
Eugene Glass	University of Colorado
Philip Hatland	San Francisco State University
Carson Nolan	American Printing House for the Blind
Ferne Roberts	Hunter College of the City University of New York
Pearla Tait	Florida State University
Morris S. Vitelis	University of Pennsylvania (Emeritus)

DISSEMINATION PROGRAM

Educators of the visually handicapped and interested professionals were periodically provided information related to project objectives and activities. A series of demonstrations/presentations was conducted during the 39 months of the project. Feedback obtained from the sessions was utilized to modify existing dissemination activities and determine the receptivity of various product formats. An awareness of future training programs and project manual also was provided by the dissemination efforts. A listing of the dissemination activities follows:

Presentations/Demonstrations

1975

April	Council for Exceptional Children (CEC), Annual Convention -- Los Angeles
June	Jean Piaget Society, Annual Symposium--Philadelphia
November	Mid Atlantic Regional Association for Education of the Visually Handicapped (AEVH) Conference -- Wilmington, Delaware
December	Texas Education Agency, Piagetian Conference -- Dallas

1976

January	Piaget and the Helping Professions Conference -- Los Angeles
March	Workshop, Boston College -- Newton
April	Council for Exceptional Children (CEC) Annual Convention -- Chicago
April	Workshop, Hunter College -- New York
June	Jean Piaget Society -- Philadelphia
July	Association for Education of the Visually Handicapped (AEVH) Convention -- Louisville

July	Texas Council for Exceptional Children -- Houston
September 1976 to May 1977	Six regional workshops sponsored by the Texas Education Agency
1977	
January	Training Colloquium -- Harlingen, Texas
April	Council for Exceptional Children (CEC) Annual Convention -- Atlanta
May	Jean Piaget Society -- Philadelphia
June	South Central Regional AEVH Conference -- Tulsa
July	Texas Council for Exceptional Children -- Dallas
September	Mid Atlantic Regional AEVH Conference -- Pittsburg
September	Symposium on Research Directions in Childhood Visual Impairment -- University of Michigan, Ann Arbor
September	New England Regional AEVH Conference -- Worcester
September	Faculty-student workshop, Boston College -- Newton

Articles

The Piagetian Approach to Visually Handicapped Education -- Fall, 1976, DVH Newsletter

Comparison of the Performance of Blind and Sighted Subjects Ages 6-10 Years on the Rotation of Squares Test -- Fall, 1976, Education of the Visually Handicapped.

OVERVIEW: THE SYSTEMS APPROACH OF THE COGNITIVE REMEDIATION OF BLIND STUDENTS

(Remediation Systems Manual)

The systems model which is used in today's education is derived from a design assembled for the Department of Defense by the Rand Corporation. The efficiency of the approach led President Johnson to order its introduction into all federal departments and agencies. PPBES, Planning, Programming, Budgeting, Evaluation System, was introduced to education through the U. S. Office of Education Bureau of Research in the late 1960s (Sabine, 1973).

Whether designed for management in business or education, the objectives for utilizing a systems approach are similar. A system is often defined as a "set of parts coordinated to accomplish a set of goals" (Churchman,1968). A brief overview of a system should include the following seven points:

1) Identification of Needs
2) Formulation of Objectives
3) Development of Program
4) Implementation of Program
5) Evaluation of Implementation
6) Revision of Program
7) Implementation of Revision

The use of the system provides improved flow of information, early identification of potential problems, regular ongoing evaluation, and elimination of last minute planning. All of the above permit the administrative personnel to make effective policy decisions without time consuming involvement in every project activity.

While the systems approach utilized in the "Cognitive Remediation of Blind Students Project" (CRP) was by no means unique, it was specific to the needs inherent in the project's experimental design. The simplicity inherent in this system allowed a clear, concise review of the entire network of interrelated processes involved in the CRP.

The three subsystems of the CRP, (1) *Master Teacher Training*, (2) *Student Remediation*, and (3) *System Planning and Operating*, functioning as a unit (Figure 1), are flexible; they permit the gathering of information and the introduction of appropriate changes. The use of the systems approach to decision making is most properly viewed in its entirety, *i.e.*, where interaction of one component with another and subsequent feedback, evaluation, and modification are related and ongoing. As subsystems they can not operate independently. Yet, in order to obtain an understanding of the CRP's internal working machinery in a relatively short amount of time, an adapted approach to the three subsystems is necessary.

MASTER TEACHER TRAINING SUBSYSTEM (Figure 4)

Consistent with the goal of the CRP, several evaluative instruments were selected, including (1) *The Flanders System of Interaction Analysis* (Flanders,1966), *(2) The Runners Studies of Attitude Patterns* (Runner, 1973), (3) *Individual Cognitive Demand Schedule* (Lynch and Ames, Undated), and (4) *Process Oriented Survey*, (B-1)*.

Two teachers who had only limited background in Piagetian theory and Special Education were selected for training. The appropriate evaluative instruments were administered prior to the onset of training and scores were profiled (B-2)*. The teachers' strengths and weaknesses in Piagetian theory and teaching strategies were ascertained and a specific training program was devised and implemented. This program included a concentrated five-week workshop and regularly scheduled monthly in-service training seessions (B-3)*.

As the project progressed, additional waves of data were collected on the teachers, and evaluation profiles were updated. The training program was then modified as necessary to accommodate specific teacher needs. In addition, the operation of the *Master Teacher Training* subsystem was monitored and reported out through bimonthly field reports to the *System Planning and Operating Subsystem*. Data gathered on teacher evaluation and training were compiled for future reference in a Teacher Training Manual.

STUDENT REMEDIATION SUBSYSTEM (Figure 5)

The sample of experimental and control subjects was selected from a larger group assessed during an earlier study (Stephens & Simpkins,1974) (C-1)* Master

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*Refers to subsystem as indicated in Figure 1.

Teachers, trained in the administration of Piagetian Assessments, tested the subjects prior to remediation (C-2)*. The experimental subjects' scores were profiled and specific remediation procedures and modules were prepared. These modules were implemented in individual remediation sessions (C-3)*. The training procedures and modules were evaluated and revised as necessary. At the end of the first year of remediation both the experimental and control subjects were assessed and appropriate revisions were made on the experimental subjects' profiles. The preparation of modules and remediation sessions continued through May, 1976. At that time a post test was administered, and these data, along with the two prior waves of data, were statistically analyzed. Throughout the two years of remediation, information on the Student Remediation Subsystem was reported to the System Planning and Operation Subsystem via bi-monthly field reports.

SYSTEM PLANNING AND OPERATING SUBSYSTEM (Figure 6)

As noted in discussions of the previous two subsystems, data were gathered on both student remediation activities and teacher training. These data were reviewed, evaluated, and appropriate recommendations relating to the interaction of the subsystem were made (A-1)*. These recommendations were reviewed by the Project Director and staff. Modifications were suggested for both the Student Remediation and Master Teacher Training Subsystem. In addition, modifications were made as necessary in the collection of data and operation of the system planning process.

Ultimately the information and data collected were used as a basis for the following four products of the study: (1) Final Project Report, (2) Remediation Systems Overview, (3) Teacher Training Manual, and (4) Student Activities Guide.

An example of an operating system follows:

Student 14 was included in the experimental sample. After he was assessed on the Piagetian reasoning assessments, his scores were profiled. The results indicated a deficit in the area of spatial relationships. Appropriate modules were developed to remediate this specific deficit area. Following implementation of a module the student was informally reassessed by the Master Teacher. In addition, the activities and materials used during the session were evaluated. If little or no progress had been made, additional activities were developed and implemented. Regular reports were also forwarded to the *System Planning and Operating Subsystem*. These in turn were discussed and appropriate recommendations made. In this case, further guidelines were suggested for teacher training in the area of spatial relations. Also general suggestions were made on further module preparation and evaluation.

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*Refers to subsystem as indicated in Figure 1

In conclusion, the basic features of this approach --identification of objectives, systematic analysis of available alternatives, allocation of resources to programs and evaluation of program effectiveness -- permitted an increase in accountability and an efficient allocation of responsibilities. The three subsystems functioned together to reevaluate, replan, and revise the system. As subsystems they could operate independently.

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Lynch, W. W., & Ames, C. *Individual cognitive demand schedule*. Center for Innovation in Teaching the Handicapped. Bloomington, Indiana: Indiana University, undated.

Runner, K. *A theory of persons: Runner studies of attitude patterns*. Philadelphia: Research for Better Schools, 1973.

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FIGURE 1
OVERVIEW OF THE COGNITIVE REMEDIATION PROJECT SYSTEM

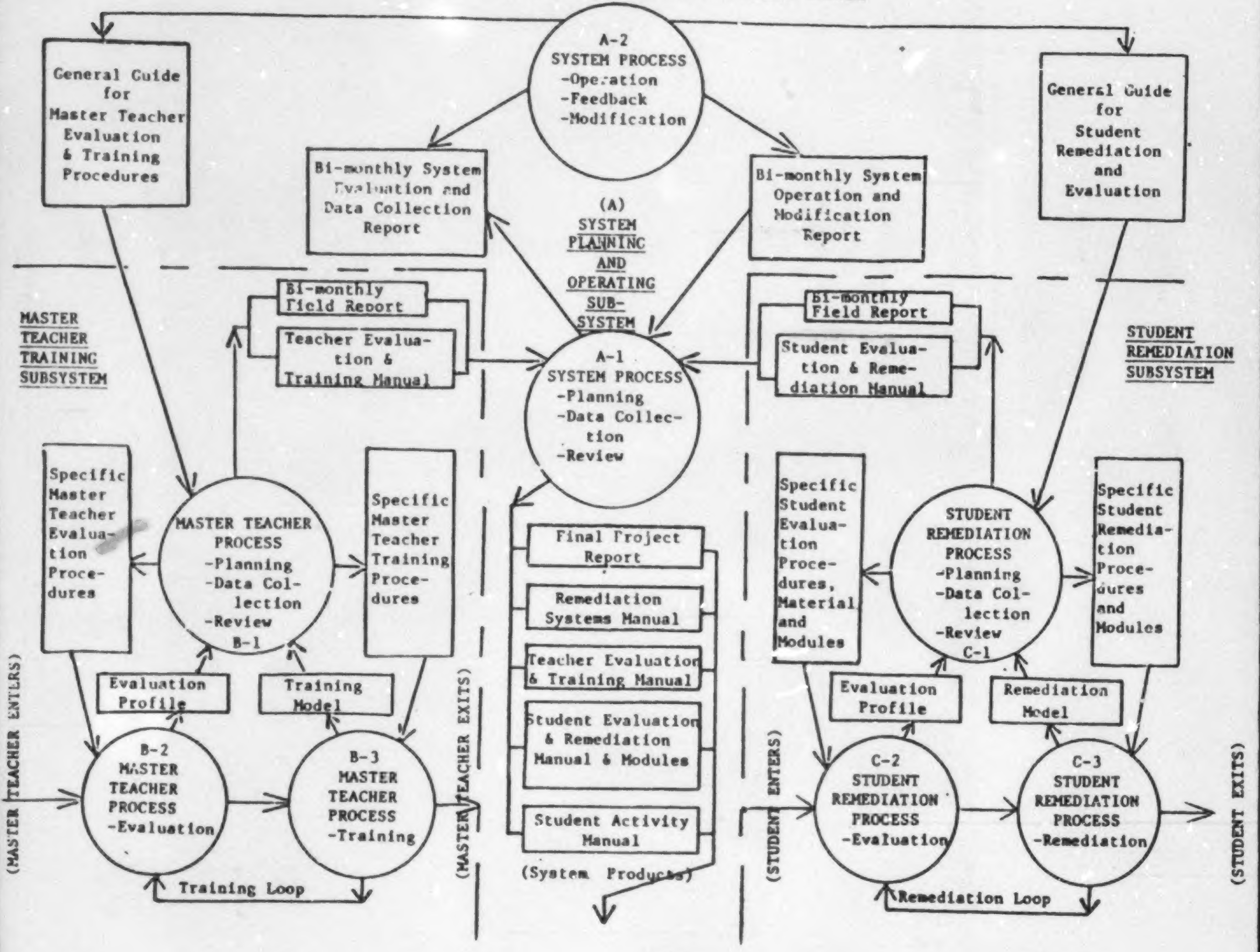
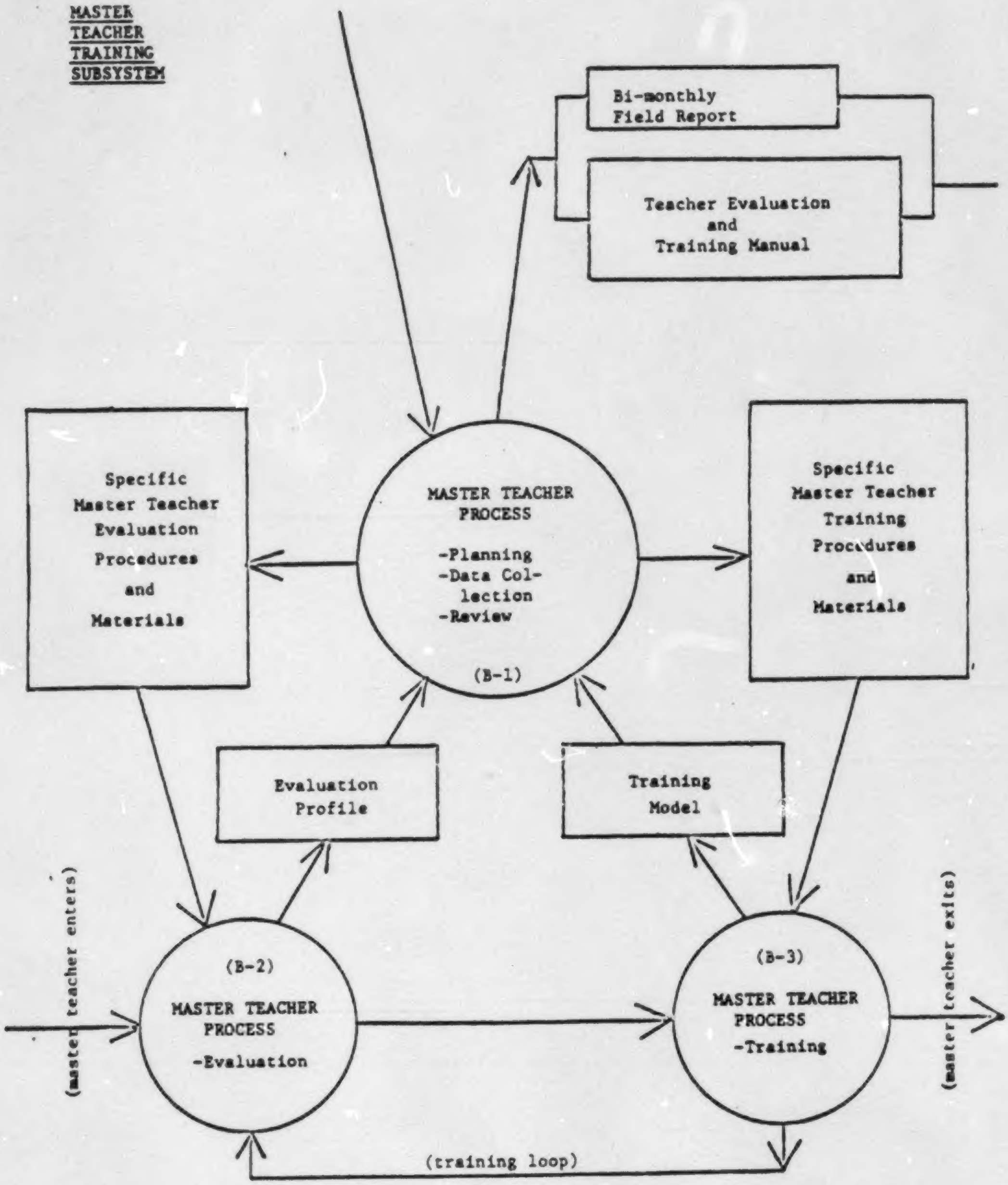

A-2
SYSTEM PROCESS
-Operation
-Feedback
-Modification
General Guide for Master Teacher Evaluation & Training Procedures
General Guide for Student Remediation and Evaluation
Bi-monthly System Evaluation and Data Collection Report
Bi-monthly System Operation and Modification Report
(A) SYSTEM PLANNING AND OPERATING SUB-SYSTEM
MASTER TEACHER TRAINING SUBSYSTEM
STUDENT REMEDIATION SUBSYSTEM
Bi-monthly Field Report
Teacher Evaluation & Training Manual
Bi-monthly Field Report
Student Evaluation & Remediation Manual
A-1
SYSTEM PROCESS
-Planning
-Data Collection
-Review
Specific Master Teacher Evaluation Procedures
MASTER TEACHER PROCESS
-Planning
-Data Collection
-Review
B-1
Specific Master Teacher Training Procedures
Final Project Report
Remediation Systems Manual
Teacher Evaluation & Training Manual
Student Evaluation & Remediation Manual & Modules
Student Activity Manual
(System Products)
Specific Student Evaluation Procedures, Material and Modules
STUDENT REMEDIATION PROCESS
-Planning
-Data Collection
-Review
C-1
Specific Student Remediation Procedures and Modules
Evaluation Profile
Training Model
Evaluation Profile
Remediation Model
(MASTER TEACHER ENTERS)
B-2
MASTER TEACHER PROCESS
-Evaluation
B-3
MASTER TEACHER PROCESS
-Training
Training Loop
(MASTER TEACHER EXITS)
(STUDENT ENTERS)
C-2
STUDENT REMEDIATION PROCESS
-Evaluation
C-3
STUDENT REMEDIATION PROCESS
-Remediation
Remediation Loop
(STUDENT EXITS)

FIGURE 2



MASTER TEACHER TRAINING SUBSYSTEM

Bi-monthly Field Report
Teacher Evaluation and Training Manual
Specific Master Teacher Evaluation Procedures and Materials
MASTER TEACHER PROCESS
-Planning
-Data Collection
-Review
(B-1)
Specific Master Teacher Training Procedures and Materials
Evaluation Profile
Training Model
(master teacher enters)
(B-2)
MASTER TEACHER PROCESS
-Evaluation
(B-3)
MASTER TEACHER PROCESS
-Training
(master teacher exits)
(training loop)

FIGURE 3

STUDENT REMEDIATION SUBSYSTEM

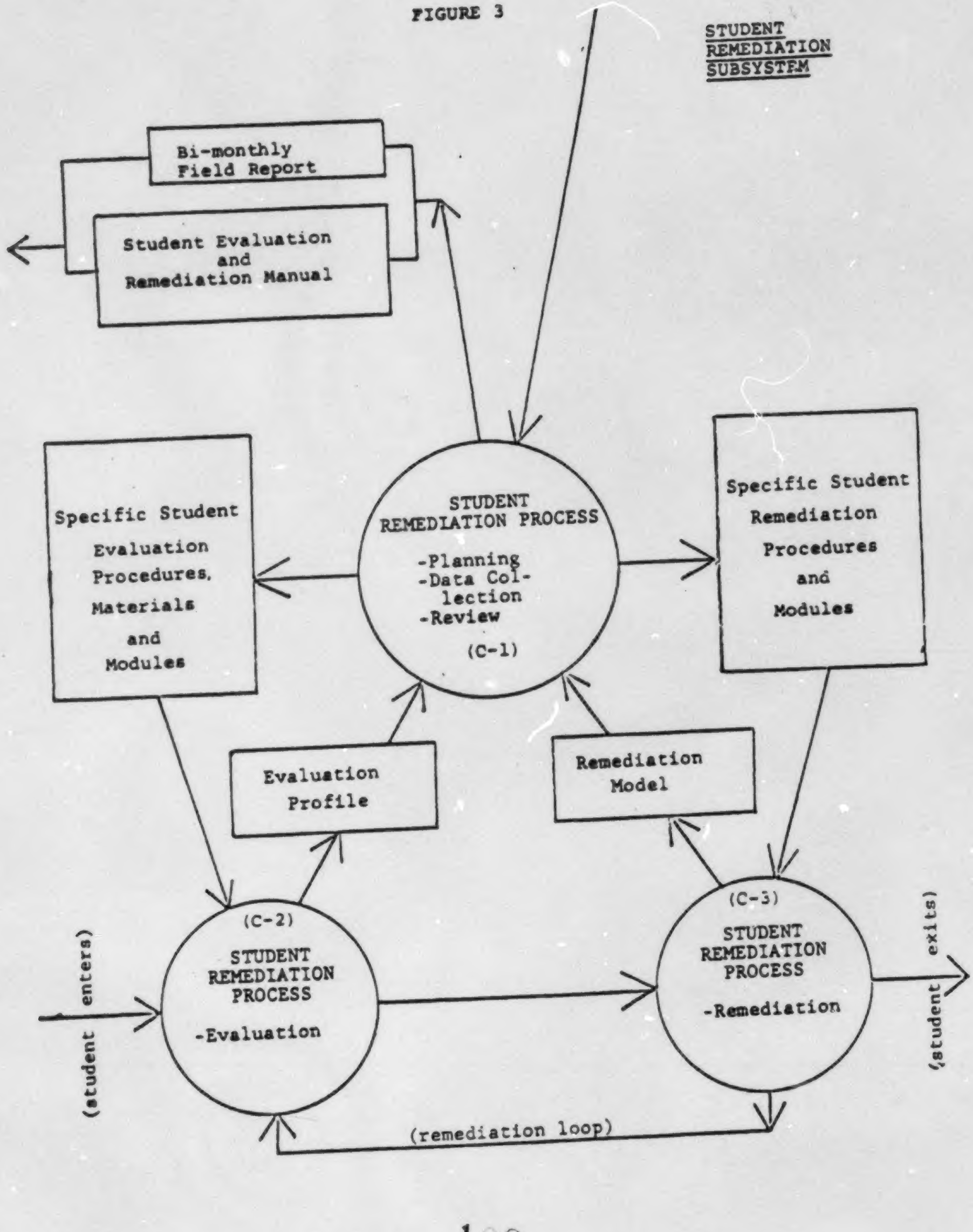
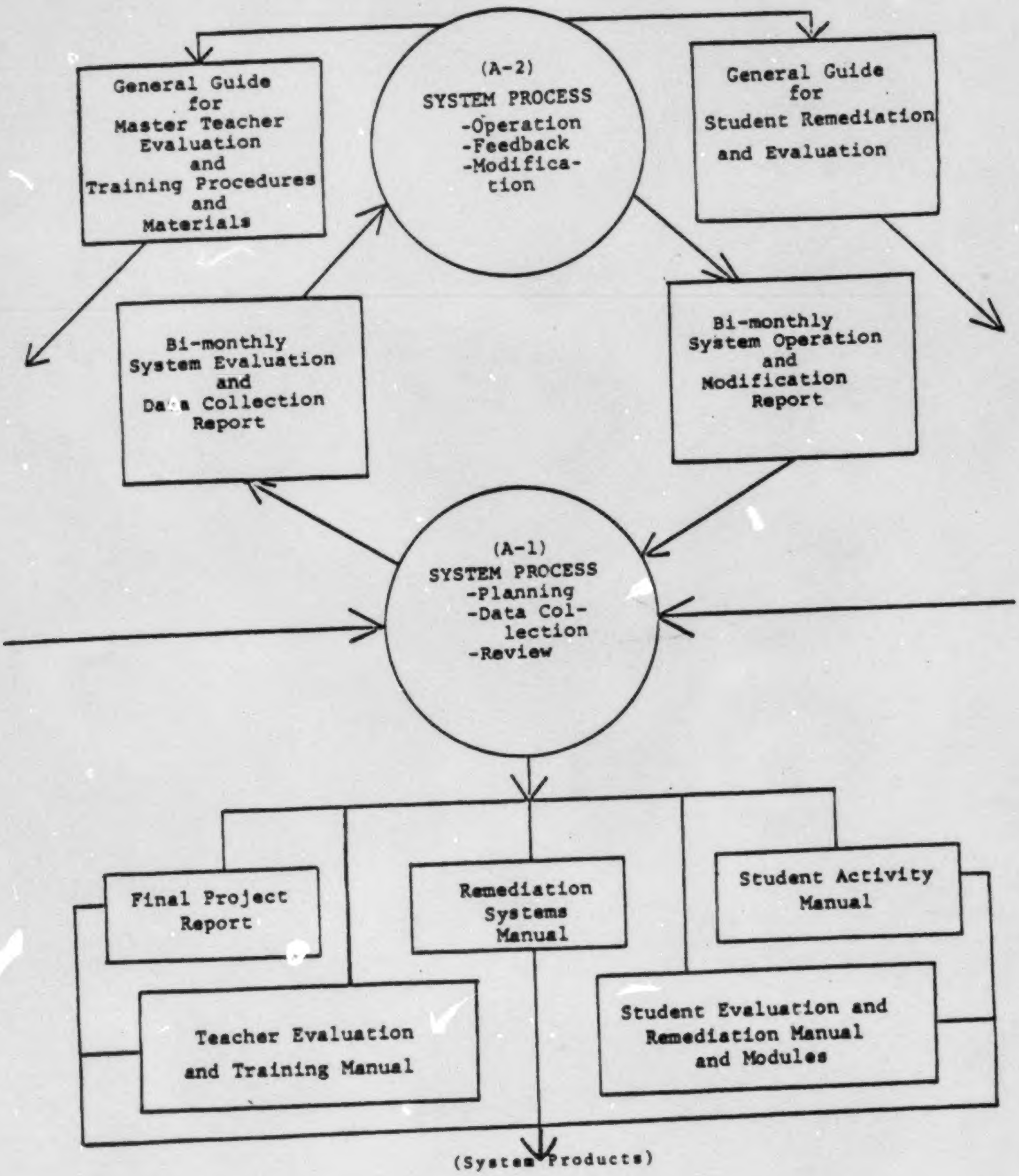

Bi-monthly Field Report
Student Evaluation and Remediation Manual
Specific Student Evaluation Procedures, Materials and Modules
STUDENT REMEDIATION PROCESS
-Planning
-Data Collection
-Review
(C-1)
Specific Student Remediation Procedures and Modules
Evaluation Profile
Remediation Model
(C-2)
STUDENT REMEDIATION PROCESS
-Evaluation
(C-3)
STUDENT REMEDIATION PROCESS
-Remediation
(student enters)
(student exits)
(remediation loop)

FIGURE 4

SYSTEM PLANNING AND OPERATING SUBSYSTEM


General Guide for Master Teacher Evaluation and Training Procedures and Materials
(A-2) SYSTEM PROCESS -Operation -Feedback -Modification
General Guide for Student Remediation and Evaluation
Bi-monthly System Evaluation and Data Collection Report
Bi-monthly System Operation and Modification Report
(A-1) SYSTEM PROCESS -Planning -Data Collection -Review
Final Project Report
Remediation Systems Manual
Student Activity Manual
Teacher Evaluation and Training Manual
Student Evaluation and Remediation Manual and Modules
(System Products)

OVERVIEW: THE TRAINING MANUAL FOR TEACHERS OF THE VISUALLY HANDICAPPED: A PIAGETIAN PERSPECTIVE

The growth in reasoning which occurred during the present study as training was provided congenitally blind students was attributed to appropriately designed reasoning activities. Yet, there is realization that the appropriate design and presentation of these activities was a direct result of: (1) the insight that the pupil's teacher had into the work of Jean Piaget, work which supplied a theoretical framework for the study, (2) the skill which this teacher had in the administration and interpretation of the assessments that were used to determine the pupil's level of reasoning ability, (3) the teacher's ability to design activities that were commensurate with the pupil's present level of functioning, and (4) the teacher's success in emphasizing the "processes" rather than the "product" of thought as students engaged in ongoing reasoning activities. To achieve these qualities both preservice and inservice training were provided to the project teachers. There is belief that both understanding of and skill in the use of these methods are essential to successful remediation of Piagetian reasoning. For these reasons it was viewed as necessary to supply a teacher training manual as companion material to the student activity guide which also is a product of the present study; i.e., the knowledge presented in the teacher training manual is a prerequisite to successful use of the student activity guide. This approach to teacher training has been validated by its use (1) in training project teachers, (2) in graduate classes which were designed to equip teachers in the remediation of cognitive deficits, (3) in summer institutes which provided inservice training, and (4) in numerous intensive staff training workshops carried out by public schools. Repeated use of the training approach in various settings served to provide the evaluation, feedback and revision that is essential to the generation of valid training techniques.

The content of the teacher training manual seeks to provide:

(1) An overview of Piaget's theory of cognitive development and the implications derived from it for the educating of visually handicapped students,

(2) a general discussion of the research which has related Piagetian theory to classroom activities, and more specifically to activities with the visually handicapped,

(3) a discussion of Piagetian assessment and how information obtained through this clinical method of assessment can be applied during the development of the child's individual educational program,

(4) a discussion of the techniques employed to promote cognitive development through the design, development, and implementation of individually appropriate reasoning activities, and

(5) an extensive listing of available teacher resources which can augment instructional techniques designed to promote Piagetian reasoning.

OVERVIEW: STUDENT ACTIVITY GUIDE

Description

The Student Activity Guide is a compilation of modules which serve as basis for the remediation of specific cognitive deficits which may be evidenced by the visually impaired student. Within each module there is a brief introduction that specifies the overall objective(s) of the activities, the anticipated type of student performance, and the level of cognitive functioning required by the activities. Also,there is a listing of the Piagetian concepts which underlie successful attainment of the objective(s). The instructional activities provide experiences in areas of logical reasoning, and constitute a program that appeals to a variety of interests. THEREFORE, A MODULE IS DEFINED AS AN INTERRELATED SERIES OF ACTIVITIES BASED ON A SPECIFIC THEME WHICH STRESSES THE DEVELOPMENT OF ONE OR MORE AREAS OF PIAGETIAN REASONING ABILITIES. Activities are hierarchically arranged in terms of difficulty; i.e., skills and concepts attained at a preceding level serve as a necessary foundation for the development of reasoning at a higher level. Although the activities are hierarchical in nature, rigid adherence to the specified sequence is not necessary if the student gives evidence that the particular cognitive abilities which are prerequisite for involvement in higher level activities have been attained. The Student Activity Guide contains 19 modules which encompass a total of 120 student activities. The series of activities set forth in each module is designed to provide experiences which promote the development of logical thought in one or more of the following Piagetian areas:

1) Classification: the process of arranging objects or events into groups or categories. For example: the student is presented different textured paper cut into various shapes (triangles, circles, squares, etc.) and sizes (big, little). The student realizes that the papers can be grouped not only by texture, but also by shape or size.

2) *Conservation*: the realization that changing the shape of an object does not alter its amount. For example: if a cup of pizza dough is rolled into a 12" circle, the amount of dough remains the same even though the shape has been altered.

3) *Spatial Relations/Mental Imagery*: the process of achieving spatial orientation and of manipulating the mental images of objects rather than the concrete objects themselves. For example: a person can describe the location of the hands of a clock when it is 4:40 even though the present time is 12:05.

4) *Formal/Abstract Thought:* the ability to think abstractly, to operate on operations rather than on concrete objects, to formulate and test hypotheses. For example: If a student is presented with bottles of colorless liquid and told that a certain combination will result in a yellow color, the student will systematically combine the liquids until he produces the desired color.

Activities contained within the 19 modules address either concrete or formal level thought. In order to provide for the qualitatively varying levels of thought that the individual child might possess in the four reasoning areas defined above, activities are supplied which have a similar theme but which require different levels of performance in various areas of reasoning. For example, assessment information could indicate that the child is functioning at the lower concrete level in conservation, but at the upper concrete level in classification. In this instance, conservation type activities which have been designed to promote transition from concrete to formal level reasoning would be appropriate, but classificatory activities would not be appropriate at this level. Generally, the activities contained in the modules can be adjusted to different levels of reasoning abilities. Although the activities do not represent an exhaustive listing of ones which can be developed to promote the growth of concrete and formal level reasoning, they do represent the type of activities that were developed for a specific population of visually impaired children during the Stephens, Grube, and Fitzgerald (1977) study. *It is critically important that the teacher understand that these activities serve only as a model for the development of further activities which address the specific needs of the students with whom they are working*. Certainly the activities contained in the *Student Activity*

Guide are not individually appropriate for all children. To use these activities as a total curriculum or "cookbook" is not warranted and is contrary to the principles underlying the application of developmental theory to individualized instructional programs. In order to provide an individual program for each youngster, the teacher should use her own creative ideas plus any available curriculum which is appropriate. Skill is required not only to *devise* individually appropriate activities but also to *select* individually appropriate ones.

The following activity, "Sound of Candlelight," is one of six activities within the module, "The Whistling Candle". This activity is typical of the 111 included in the *Student Activity Guide*.

MODULE I

THE WHISTLING CANDLE

Introduction:

A light sensor translates intensity of light into frequency of sound; with bright light, the light sensor emits a high-pitched sound, with dim light, a low-pitched sound; when the light level changes, so does the pitch of the sound. The light sensor will detect light levels as low as that of a single candle and is, thus sensitive enough to permit the student to explore the interaction of oxygen and a lighted candle in an airtight container.

The activities in "The Whistling Candle" are organized to help the student investigate the interactions of oxygen and fire experimentally. They encourage him/her to define the variables, to control these variables, to alter the value of each variable systematically, and to compare these results with his/her initial results.

Piagetian Concept:

Reversibility of thought and logical combinations.

ACTIVITY 1

The Sound of Candlelight

Purpose: First the student must understand and learn to use a light sensor. Then the teacher can encourage the student's interest in identifying the factors which cause a flame to go out when a lighted candle is placed in an airtight container.

Materials:

16-ounce beaker or Pyrex measuring cup
birthday candles, 24
light sensor (audicator)*
modeling clay
matches or cigarette lighter
writing instruments (pen, pencil, paper, slate and stylus)

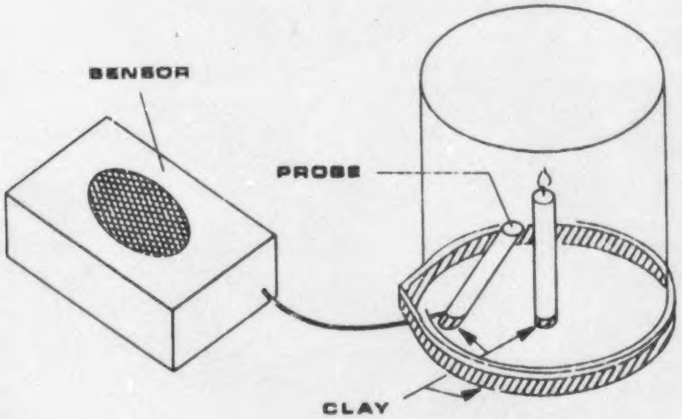
Teacher Preparation:

Read activity and become familiar with procedures
Collect materials and assemble the Whistling Candle.
Conduct activity before presenting it to the student.

Directions for assembling the Whistling Candle:

Roll a ball of clay into a strip equal in length to the circumference of the beaker and place this around the top rim of the beaker. Invert the beaker and place it on the table. Place the probe (tip) of the light sensor inside the container, under the clay rim at the spout opening. Place a thin strip of clay over the wire of the probe to insure an airtight fit. Be sure the probe (tip) of the sensor is pointed upward toward the top of candle. Use a small piece of clay to hold the candle upright within the container.

*Available from: Science for the Blind
221 Rock Mill Road
Bala-Cynwyd, PA 19004



Time Requirement: One session, approximately 45 minutes

Procedures

1) Allow the student to explore the light sensor (audicator), learning that the pitch of sound emitted from the light sensor varies with the intensity of light falling on the sensor.
2) Turn on the light sensor in a partially darkened room. Note the sound emitted when it is pointed toward the flame of a candle. Note the sound emitted when pointed **away** from a lighted candle. With the light sensor pointed **toward** the flame, blow the flame out and note the change in sound. Light the candle again; ask the student to listen to the light sensor (audicator) and to indicate when the flame is extinguished.

3) Present the student with the beaker and explain the reasons for using a beaker with a clay rim. (The clay rim fits around the light sensor and seals the beaker to the table, thus preventing any seepage of outside air into the beaker.)

4) Before lighting the candle, determine what the student expects will happen by asking questions such as, "How long will the candle burn? Will it burn until the wick is gone? Is there a way to extinguish the candle without blowing it out or pouring water over it?" (Answers will give the teacher insight into the student's thought processes and thus help the teacher to guide the student toward appropriate hypotheses.)

5) Turn on the light sensor, light the candle, and help the student place the beaker over the lighted candle and press the clay to the table. Keep the light sensor on until the oxygen is exhausted and the flame has gone out. The pitch of sound from the light sensor will decrease until it emits the same pitch as it did before the candle was lit. Before removing the container and examining the candle, ask:

   Do you think the entire candle has been used?
   How can we measure the length of time the candle burned?
   Would a larger candle burn longer?
   If we placed two candles under the beaker and lit them, would they burn for the same length of time?
   Would the candle burn for the same length of time in a different-sized container?

6) Remove the beaker and have the student examine the candle. Ask the student to explain how the flame can go out when a portion of the candle remains in the container? (There is no oxygen.)

7) Have the student remove the clay rim from the container. Place a new candle under the beaker and repeat the experiment. Encourage the student to record what has occurred. (Oxygen entered through the lip of the beaker and the candle burned completely.)

Conclusion: The student should understand that the intensity of the flame (and consequently the sound from the light sensor) diminishes as the oxygen in the container becomes depleted.